The effect of Indian dance on gait and balance of children: Comparing Grade R and Grade 7 children

By

Nikita Cara

2925938

Thesis submitted in partial fulfilment

of the requirements for the

Degree of Master of Science Biokinetics

Supervisor: Dr B.S. Andrews

Co- Supervisor: Dr S Bassett

University of Western Cape

January 2016

Abstract

Through the process of motor learning and control, new skills are then developed. There are various physical activities that enable the development of new motor skills, one being dance. Numerous studies have found that dance has improved sensorimotor control of body sway following just a single dance session. Furthermore, learning dance engages a variety of cognitive resources that improve postural control of children. Dancing therefore contributes to the development and refinement of the fundamental motor skills like gait and balance.

The aim of this research was to determine the effect of dance training on gait and balance of Grade R and Grade 7 school children, and to investigate which age group would best demonstrate these effects. This study was conducted using an intervention and control group. The Grade R intervention group constituted a sample of thirty-four participants, the Grade R control consisted of twenty-seven participants, the Grade 7 intervention group and control group consisted of twenty-one participants each.

Three different testing instruments were used; a 10-meter walk test for stride pattern analysis, a dynamic balance test known as the tandem gait and the static balance test known as the tandem stance balance test. Both the control and experimental group were required to perform these tests before and after the intervention period. The dance training lasted a period of six weeks and was conducted on a weekly basis.

Following the intervention it was found that only Grade R stride pattern in terms of stride frequency was significantly changed and that no significant changes

were seen at any time for Grade 7 children stride pattern and balance. The balance changes were seen for both Grade R intervention and control groups, showing that the children were improving with physical activity, which cannot be attributed to dance alone.

This highlights that training should be started at the young age, and that physical activity programs like dance are good and diverse options to consider when designing such activities.

Declaration

I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Signature: Nikita Cara

Date

Dedication

This thesis is dedicated to my parents for always motivating me to pursue my dreams. If it were not for you and your faith, I would not have been striving for great heights. Your love and support will always be cherished.

Acknowledgments

This chapter of my life has truly been an amazing and challenging journey. I herewith would like to express my gratitude towards many people.

To my supervisor Dr Barry Andrews, thank you for always showing that there is light at the end of the tunnel. Your guidance and mentoring through this process has only made this experience so much more enjoyable. Thank you to Dr Susan Bassett for the feedback through this process; your guidance and knowledge is always appreciated.

A huge thank you to the participating schools, parents and children, thank you for offering your facilities and time.

To my siblings, Jyoti and Depesh Cara. You both have known when I needed cheering the most. I feel really extremely blessed; I love and thank you for believing in me. To my best friend Jignesh Patil, you have always supported and been there for me. Thank you seeing the best in me and for giving that extra push and motivation. I am truly lucky to have you in my life.

To the Division for Post Graduate Studies, thank you for providing me with opportunities and adventures within my field of study. Had it not been for the National Research Fund, I would not have been privileged to further my education, thank you.

Table of Contents

Appendices

List of Tables

List of Figures

Chapter 1

Introduction

'Movement is a medicine for creating change in a person's physical, emotional, and mental states.' - *Carol Welch*

Human movement is a complex task that is comprised of many biomechanical factors which operate simultaneously throughout the lifespan in order to build up the complex movement pattern that is used in daily living, including sport (Davids, Button, & Bennett, 2008). According to Haywood and Getchell (2009), motor development occurs during growth and maturation, whereas the process of motor learning is developed through practice and experience. All movement stems from this neuromuscular process, known as motor control, in which skills are acquired.

Motor development involves muscle adaptation and Sahli et al. (2013) stated that the majority of human motor development takes place from birth until the ages of five to six years. In a study by Krasnow (2013) it was further found that children of ages three to four years can gallop and hop, but many are unable to skip, while the majority of children aged six are able to skip. The reason for this is because skipping makes use of a contra-lateral pattern of standing locomotion where the children have not developed the ability to dissociate and coordinate between the upper body and lower body (Phillips, 2011). These differences are due to motor developments that occur as we age, in order to develop the movement patterns required for the performance of complex skills. These findings were substantiated by Assaiante (1998) who also found that children at the age of six are at a turning point in both postural and locomotor equilibrium control.

Skill acquisition is not solely based on a child's age but is also impacted by the everyday exposure to the environment, as well as various movement patterns (Newell, 1991). Two fundamental motor skills required for the advancement of human development are balance, to ensure stability, and gait, for the purpose of basic locomotion (Rival, Ceyte, & Olivier, 2005). Furthermore, balance is not solely determined by standing still and walking, it is also developed through our various daily bodily positions. Thus positions such a kneeling, sitting and crouching require an increased amount of balance management (Grosse, 2008).

Through this process of motor learning and control, new skills are then developed. There are various physical activities that enable the development of new motor skills, one being dance. Guzmán-García, Johannsen and Wing (2011) found that dance improved sensorimotor control of body sway following just a single dance session in elderly people. Furthermore, learning dance engages a variety of cognitive resources that improve postural control of children (Krasnow & Wilmerding, 2015).

A greater range of motion, coordination, strength and endurance are more apparent in dance than in most other physical activities. This is accomplished through movement patterns that teach coordination and kinesthetic memory. This form of motor training utilizes the entire body and is an excellent form of exercise for total body fitness (Hackney & Earhart, 2010b). The National Dance Education Organisation (2005) states that dance offers an avenue to expand movement possibilities and hence skill development.

Dancing therefore contributes to the development and refinement of fundamental motor skills like gait and balance (Hackney & Earhart, 2010a). Jackson (2012) highlighted the usefulness of dancing and explained how it could be used to help one learn how to control balance and gait. Dance training has also been shown to improve the quality and speed of the motor response to imbalance as it develops the suppleness, muscular strength and balance abilities linked to coordination that enable the dancer to anticipate slight balance adjustments (Bruyneel, Mesure, Pare, & Bertrand, 2010). No matter which form of dance you interact with, posture, poise and grace are key factors.

The relationship that exists between age and balance is non-linear, and the greatest improvement in balance is typically displayed between the ages of six and eight years (Figura, Cama, Capranica, Guidetti, & Pulejo, 1991). This statement is supported by Assaiante (1998) who stated that the age of six constitutes a turning point in both postural and locomotor equilibrium control. Thus children aged six to seven years were recruited for this study to allow for the best analysis of the effect of dance intervention on participants at a similar motor development stage. Furthermore, the skills that were studied, as per the research of Hackney and Earhart (2010a), were balance and gait.

Statement of the Problem

Research has been conducted on the biomechanical benefits of dance on gait and balance in children; however sufficient studies have not be done on school children focusing on school-based dance training. Various studies have focused on dance for improvement of health and well-being for increasing physical activity. It has however been documented that children in today's world do not participate in physical activity as regularly as before, and that physical activity levels are declining from childhood to adulthood (Verstraete, Cardon, De Clercq, & De Bourdeaudhuij, 2006). Children should be able to engage in an extra-mural activity such as dance in order to not only increase physical activity, but also develop their functional characteristics such as fundamental motor skills. This comprises of locomotion, stability and manipulative skills. Dance can also be seen to improve self-awareness of movement, however direct biomechanical benefits on parameters such as stride pattern and stability have not been identified through the motor development phases of children. However, Krasnow and Wilmerding (2015) discuss dance science and motor behaviour for current dancers and practitioners. With dance being identified as a means to provide a vast range of physical benefits to all phases of life, it also provides emotional skills which then result in layered learning and the development of a holistic individual (Lorenzo-Lasa, Ideishi, & Ideishi, 2007).

Aim

The aim of this research was to determine the effect of dance training on the performance of gait and balance of Grade R school and Grade 7 school children, and to investigate which age group would best demonstrate these effects.

Research Objectives

The specific objectives of this study are as follows:

- To investigate the effect of dance training on the gait of Grade R children
- To investigate the effect of dance training on the gait of Grade 7 children
- To investigate the effect of dance training on gait between Grade R and Grade 7

- To investigate the effect of dance training on the balance of Grade R children
- To investigate the effect of dance training on the balance of Grade 7 children
- To investigate the effect of dance training on balance between Grade R and Grade 7

Research Hypothesis

- It is hypothesised that dance training will result in improvement in the gait of both the Grade R and Grade 7 children
- It is hypothesised that dance training will result in improvement in the balance of both the Grade R and Grade 7 children
- It is hypothesised that dance training will result in greater improvements in gait and balance of Grade R children compared to Grade 7 children

The Significance of the Study

According to the Healthy Active Kids South Africa (HAKSA) Report Card 2014, there is a concerning rise in the trend of physical inactivity of South African children (Draper, Bassett, de Villiers, & Lambert, 2014). Therefore more awareness needs to be created around the importance of physical activity. Children need to move more and, with dance, children not only engage in physical activity but also improve their fundamental motor skills such as balance and gait control. Gait and balance are vital for activities of daily living, and dance is a fun and exciting form of physical activity, which stimulates children in many different ways (Heiberger et al., 2011). This occurs with the integration of several brain functions: kinesthetic, rational, musical, and emotional, further increasing their neural connectivity (Powers, 2010). There are stress-reduction benefits associated with any kind of dancing, cardiovascular benefits, and social benefits of feeling connected to a community of dancers (Powers, 2010).

Terminology

Balance: "In biomechanics, balance is the ability to maintain the line of gravity of a body within its base of support with minimal postural sway. Sway is the horizontal movement of the centre of gravity even when a person is standing still. A certain amount of sway is essential and inevitable due to small perturbations within the body" (Paul & Nagarajan, 2014).

Gait: Human gait is a complex patterned bipedal movement with many subtasks that must be simultaneously satisfied and that are continuously changing over the stride period. Changes occur in terms of speed, terrain, energetic efficiency and the need to locomote (Magill, 2007).

Motor Control: this refers to the functions that the neuromuscular system has in order to activate and coordinate muscles and limbs involved during the performance of a motor skill (Magill, 2007).

Motor Learning: This is a change that occurs in motor performance as a result of practice or experience. "Motor learning involves a set of internal processes associated with practice or experience leading to relatively permanent changes in motor skill” (Čoh, Jovanović-Golubović, & Bratić, 2004).

Motor Development: This refers to the patterns of change in motor perceptual and cognitive abilities that occur throughout the life span that have an influence on the performance of motor skills. The primary sources of change include physical growth and aging of the nervous (Haywood & Getchell, 2009).

Chapter Summary

This study was designed to identify what biomechanical enhancements dance training had on children in the Grade R and Grade 7. There are a variety of developmental benefits to children and this was seen as an exciting way to implement healthy growth and motor development. The dance training intervention was used in light of an extramural activity with the focus being on Indian dance.

Chapter 2

Literature Review

It is hard to imagine any functional routine or movement that does not involve some form of motor control activity. From playing a game at home with friends to working on homework at a desk, there is always some form of motor control present. This chapter will review children motor control and development, fundamental motor skills such as balance and gait, rhythm during movement and dance as a therapy and extracurricular activity at schools.

Motor control and development

Motor control is simply the process in which the brain plans and develops movement (Krasnow, 2013). Magill (2007) defined motor control as the way in which the central nervous system operates the contractions of the muscles therefore resulting in the performance of motor skills. “Motor Skills are activities or tasks that require voluntary head, body and limb movement to achieve a goal and can be subdivided into two groups: gross and fine motor skills” (Magill, 2007):

- Gross motor skills involve large muscular structures, which require less movement precision.
- Fine motor skills require small muscle structures, which require a high degree of precision.

Building on Magill, Čoh et al. (2004) found that during the execution of the movement, factors such as muscle power, external adaptation and motor control all influence the muscles. This means that any adaptation to muscle function, i.e. through motor development, will have an effect on the motor control of that individual.

On the other hand, motor development has been defined as the patterns of change in motor, cognitive and perceptual abilities that occur throughout the life span of an individual (Haywood & Getchell, 2009). It is the process in which a child develops motor skills. The primary sources of motor development are caused by physical growth and through aging (maturation).

In human beings, most of our motor development occurs from birth to the ages of five and six, as children are learning how to integrate sensory information and how to calibrate sensory feedback for the use of controlled motor skill execution (Sahli et al., 2013). However maturation is not the only reason of motor skill development (Clark, 2007). "Children move the way they do because of individual and environmental constraints" (Haibach, Reid, & Colliers, 2011), thus skills are acquired and adapted through a learning process; this motor development is presented in Figure 2.1. The lifespan view of motor skills development has been presented as "The Mountain" of motor development, however the ages presented in this Mountain are approximations (Haibach et al., 2011).

At the foundation of the mountain, the development of all reflexes and sensory changes occur. This foundation phase takes place within the first two weeks from birth and is known as the reflexive period. The next stage allows for environmental interactions. This is where the infant develops motor behaviour based on evolution and is necessary for survival. The first two weeks of the one-year-old period include movements such as sitting, standing, crawling and walking. The fundamental motor pattern period takes place from one year of age until seven years. This is the base for complex movement skills and allows for the maturation of motor skills specific to sports. Motor skills peak and are refined from the age of seven to eleven and up during the context-specific and skilfulness phases of the motor development mountain (Haibach et al., 2011).

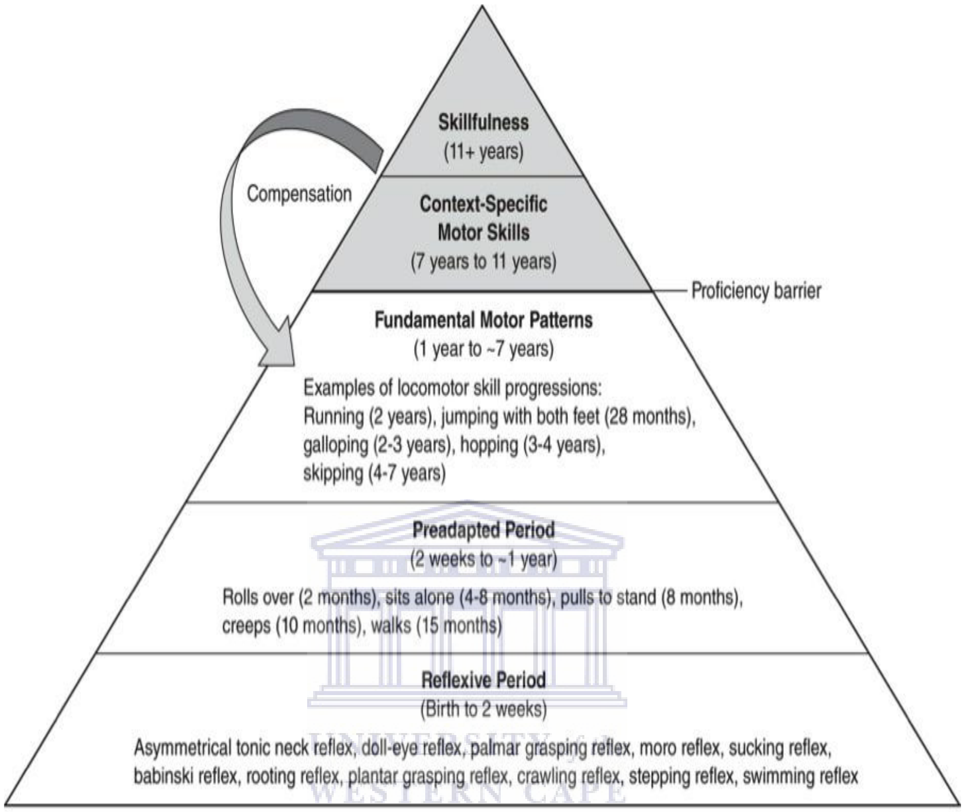


Figure 2.1. The Mountain of motor development (Haibach et al., 2011)

The entire process of skill acquisition occurs with motor learning stages. Fitts and Posner (1967) proposed a three-stage learning model (as cited in Haibach et al., 2011): The cognitive, associative and autonomous stages, which all involve learning, regardless of age. These stages can take an individual from beginner to advanced levels.

Cognitive stage - this is the identification and development of the basic components of a motor skill movement pattern. A large amount of mental activity and coordination takes place through this stage.

Associative stage - this is the linking of various components learnt in the previous stage. It is also the refining of movements into smooth action. A large amount of practice and feedback is required. Movements become more fluid with few interruptions in skill execution.

Autonomous stage - during this stage an automatic execution of skill is the goal. It involves performing a skill at ease with fluid and continuous motion. Not many people progress in this stage, as it requires an extended period of time.

Fundamental motor skills

Fundamental motor skills emerge so that the developing child can adapt to its environment. Being the foundation of movements and the starting point for movement pattern creation, children need to be confident and competent in these skills. This development process enables the tactile, explorative and various other qualities seen in a two year old. Through this process of development the child then changes from '*acquiring movement skills to becoming an adept or proficient mover*' (Haibach et al., 2011).

Figure 2.2 displays the infant motor development and acquisition of motor skills. This is a depiction adopted from Adolph and Robinson (2013) of the motor milestones achieved through early development of a child during the first sixteen months.

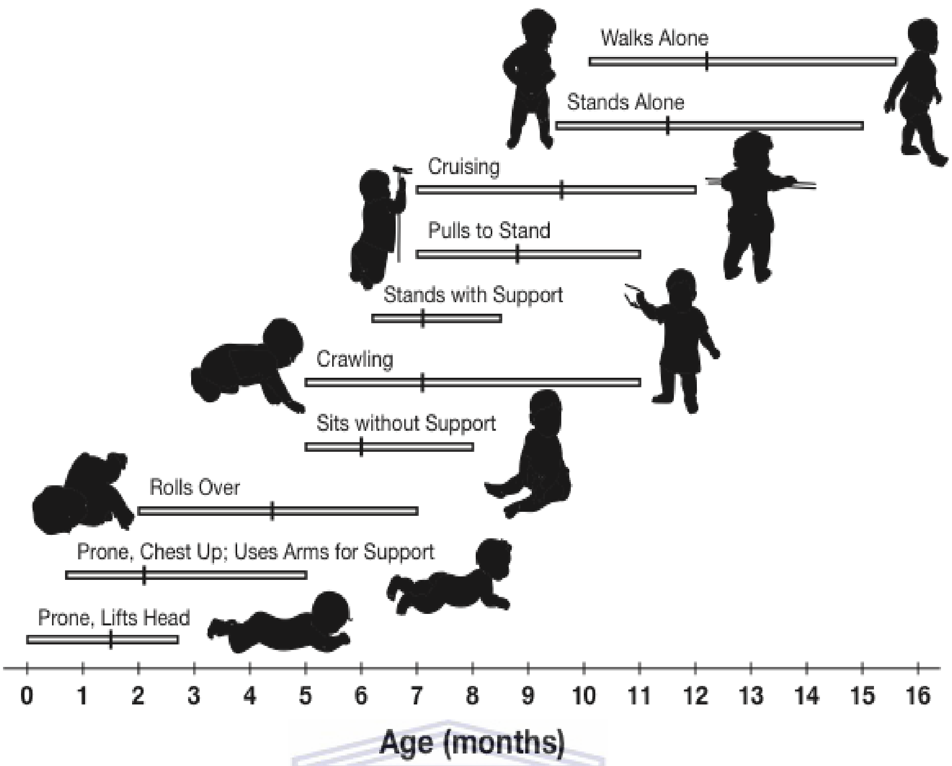


Figure 2.2. Motor milestones in early child development (Adolph & Robinson, 2013)

With reference to Haibach et al. (2011), the fundamental skills can be grouped into three categories: 1) Stability skills, which are movements around the axis of the body, i.e. movements at a specific joint in different planes with little to no movement of the base of support; 2) Locomotor skills which result in transportation, i.e. movement from point ‘A’ to point ‘B’. These activities include walking, running, skipping hopping and galloping; 3) Manipulative skills, which include a wide range of abilities such as throwing, kicking, catching and heading - skills required to move objects around.

The first two fundamental motor skills that are obtained during physical development are considered to be balance and gait (Rival et al., 2005). Although these skills are developed during our childhood, they need to be constantly engaged with and practiced in order to influence the process of locomotion (Berg & Norman, 1996).

Therefore any form of physical activity intervention should impact a child regardless of the developmental situation (Grosse, 2008).

During the first few months of walking, the infant steps with a wide base and the arms raised. These walking characteristics gradually change over the next few years, becoming kinematically and kinetically more adult-like by about five to seven years of age (Woollacott & Shumway-Cook, 1990; Tirosh, Sangeux, Wong, Thomason, & Graham, 2013). Children then begin to ambulate safer and more comfortably as walking characteristics (i.e. stride pattern) mature. The development process in walking is supported by changes that occur in the neuromuscular system as well as dimensions of the body structure during growth (Adolph, Vereijkein, & Shrout, 2003). Over time the neuromuscular system adapts the gait and movement pattern to produce a normal gait and energy effective ambulation.

Gait

Gait is a functionally rhythmical movement (Danion, Varraine, Bonnard, Pailhous, 2003). Consistency with movement during each stride is crucial as it displays intension or steadiness in the locomotor pattern. Whilst walking, an intended speed of gait is decided and with this the speed, stride length and frequency become specific. Children then learn to make adjustments to their cadence/frequency to effect changes in gait speed (Hillman, Stansfield, Richardson, & Robb, 2009).

Shumway-Cook and Woollacott (2007) summarised the developmental sequence of gait. It begins at the initial stage where the child walks rigidly with halting leg action, a wide flat-footed contact and shortened strides. The elementary stage includes a smoother pattern, improved base of support within trunk dimensions and an increase in the stride length. The development of gait steadily matures to display a reflexive arm swing, narrow base of support, relaxed and elongated gait and a heel-toe contact. Tirosh et al. (2013) stated that children between the ages of seven and nine years display a mature sense of muscular control with a steady gait speed, however it is not until about ten years of age that children are able to fully accommodate different speeds.

Balance

When walking, an individual’s dynamic balance is actively engaged as this assists in the maintenance of equilibrium (Rival et al., 2005). Verbecque, Lobo Da Costa, Vereeck and Hallemans (2015) identified that it is important to differentiate the functional characteristics and mechanisms between static and dynamic balance control. Static balance is the ability to maintain a controlled posture in a stationary and resting position. Dynamic balance is the ability to sustain a controlled posture during the performance of physical tasks (Dhanani & Parmar, 2014).

The development of balance control in humans during the lifespan has generated significant interest (Assaiante, 1998; Figura et al., 1991; Rival et al., 2005). The highlighted age in which the greatest balance improvement occurred was found to be six years, and these improvements were characterised by a decreasing magnitude and frequency of sway (Rival et al., 2005). Depending on their age, children make use of various balance techniques dependant on the task difficulty and development stage (Verbecque et al, 2015). At the age of five, children can usually manage the balance beam alone and stand on one leg for longer than 10 seconds (Pica, 2008). An improved balance is based on muscular synergies that decrease displacements of the centre of gravity while maintaining an upright stance, with adapted locomotion and technique execution during a specific sport practiced (Perrin, Deviterne, Hugel, Perrot, 2002).

Dance

'Dance is your pulse, your heartbeat, your breathing. It's the rhythm of your life. It's the expression in time and movement, in happiness, joy, sadness and envy.'

Jacques d'Amboise

Dance is referred as unique by Krasnow and Wilmerding (2015) as it is both an art as well as an athletic activity. It is the art form that involves movement of the body in a rhythmical way. In various cultures dance is performed as an expression of emotion, sharing of stories and folktales and also as a form of exercise. The setting in which dance is represented can be within a spiritual setting or a theatrical performance setting. Dance can be a profession, entertainment and or simply a passion.

Dance is a universal language that can be interpreted by all. From this, a variety of styles and categories continue to exist. A broad outline of the different types includes:

- Communal dance - a spiritual dance performed in a community to carry out a message to the audience.
- Cultural and regional folk dance - Folk dance refers to a variety of dances developed by groups or communities within a specific global region, as opposed to being made up by a choreographer.

- Recreational dance - any form of dancing that is performed for social, education and health benefits.
- Therapeutic dance - also known as dance and movement therapy, makes use of movement for the purpose of intellectual, emotional and motor function enhancement. This is also known to be an expressive form of therapy (Martinec, 2013).
- Social Dance - this form of dance emphasises on socialising and can be performed with partners, as a solo or in a large group.
- Classical dance - A dance form characterized by grace and precision of movement and by elaborate formal gestures, steps and poses (Martinec, 2013). Usually follows a set of standards and is an examinable form of dance.
- Modern dance - this form of dance was created as a form of opposition to ballet. It is a free style of dance and is always developing.
- Contemporary dance - is a recently developed genre, which falls into modern dance, however it makes use of and incorporates many different styles of dance. The dancers create art using unfixed movement patterns as its working material. Classical and modern dance techniques are used for training.
- Aerobic dance - this form of dance is for the sole purpose of improving elements of fitness. It has stemmed from the aerobic exercises and incorporated rhythmic strength and stretching routines.

Indian dance

Classical Indian dance comprises of seven main forms: Bharata Natyam from Tamil Nadu, Kathak from Northern India (Uttar Pradesh), Kathakali from Kerala, Kuchipudi from Andhra Pradesh, Manipuri from Manipur, Mohiniyattam from Kerala and Odissi from Odisha. Each form of classical dance has its own unique style and historical journey. Indian folk dances exist to express happiness (Mukherjee, Banerjee, Chatterjee, & Chatterjee, 2014). They are usually performed during festivals, season changes and any other forms of celebration. Each state and village in India has its own unique style of dance and its specific costume and jewellery to complement it. Indian dance has also included a genre of Bollywood dance, which has developed fairly recently from the Indian film industry. Song and dance has been a huge part of Indian film, with a song played every twenty minutes in a typical three-hour movie. However Bollywood dance has now become modern and incorporates all genres of dance, both east and west (Martin, 2013).

Dance and Motor Learning

In dance, motor learning is the process that allows dancers to learn and execute basic and sophisticated skills that are not acquired through normal human motor development. This motor learning takes place with increased practice and remembering of motor skills (Krasnow, 2013). If the movement is new and not part of the current motor knowledge, with correct method of instruction, correct motor learning will take place. This learning process takes place in all forms of sports. For example, within the sport/motor training of dance, the learning process is composed of visual, verbal and kinaesthetic instruction. For a dancer, learning to synergise the muscle activation pattern is part of the crux of the motor learning process. As the dancer progresses skilfully, their sequencing, timing and grading of muscle activation becomes more efficient and successful (Howse & McCormack, 2009).

Dance and Rhythm

'Everything in the universe has rhythm. Everything dances.'

Maya Angelou.

A sequenced dance movement is defined as a "rhythmic series of steps collectively forming movement". Rhythm has always been a strong basis for human interaction (Dance, 2015). Dance, as a universal human activity, involves a complex combination of processes related to the patterning of bipedal motion and to metric entrainment to musical rhythms. When a series of movements that affect fine and gross motor skills are combined in a sequence, the brain makes use of the current motor knowledge and transfers this into movement (Čoh et al., 2004).

The process of rhythmic synchronization could be considered as dance, where it is displayed through the collaboration of a variety of movement patterns. Dance is broadly defined as 'patterned, rhythmic movement in space and time" (Jain & Brown, 2001). This rhythmic movement makes use of the entire body and involves increased range of motion, coordination, strength and endurance as compared to some other physical activities.

With rhythm having been identified as a characteristic of skilful performance, balanced synchronized motor skills are developed. Rhythm is a special type of timing that underlies the acquisition and performance of motor skills (Derri, Tsapalidou, Zachopoulou, & Kioumourtzoglou, 2001). A study conducted by Zachopoulou, Derri, Chatzopoulos and Ellinoudis (2003) challenged children to synchronise their movements to an external stimuli such as music. This was conducted with children between the ages of four and six and the results displayed an improvement in rhythmic ability (Derri et al., 2001). Rhythmic movement and dance are powerful and joyful content areas for developing problem solving, creative expression and motor skills (Boswell, 2005; Amos, 2013).

Dance Training in Children

Dance has been identified as an excellent way to develop various aspects in growing children, with the physical, emotional, social and cognitive maturation processes all being facilitated by dance (National Dance Education Organization, 2005). This is accomplished through a variety of movement patterns having been put together with synchronisation and rhythm.

Through dance children are encouraged to explore and express themselves according to their own personality. No matter which form of dance you interact with, posture, poise and grace are key factors. With this the dancer is constantly engaged, and is therefore trained indirectly in coordination, balance, muscular strength and endurance. This then impacts holistically on motor fitness. If dance is performed as a routine it will then require remembering of steps and complex movement activating working memory.

Pre-school children do not conceptualise abstract processes instead they primarily learn through physical and sensory experiences (National Dance Education Organization, 2005). Interactive dance has been recognized as a fun solution to promoting a physically active lifestyle and is a good aerobic exercise to help children maintain weight. Dancing is also known to be a physically strenuous activity on the musculoskeletal system (Roberts, Nelson, & McKenzie, 2013; Miller, 2006).

In addition, scientific evidence supports dance as an effective way to obtain recommended amounts of regular physical activity. Dance may be performed at low, moderate, or vigorous intensity, for example 3-7 metabolic equivalents (METS) depending on the type of dance and age of the participant. Dance has the potential to generate health and fitness benefits and is a favoured activity that could be efficacious in promoting increased physical activity (Huang, Hogg, Zandieh, & Bostwick, 2012).

The World Health Organization (2015) states, “Physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths globally.” A sedentary lifestyle is a known risk factor in the development of chronic diseases (American College of Sports Medicine, 2013). There has been an estimated 1.9 million global deaths, which point towards physical inactivity, where sedentary lifestyle was a risk factor in the development of chronic conditions.

A good physical activity pattern is inculcated from childhood into adulthood (Dobbins, Husson, DeCorby, & LaRocca, 2013). The promotion of healthy and active lifestyles can be greatly assisted by schools playing a role in instilling active living. Thus far, there have been numerous studies conducting research regarding physical activity with school-aged children (Brooke, Corder, Atkin, & van Sluis, 2014; Dobbins et al., 2013).

Dobbins et al., (2013) conducted a systematic review and showed that school-based physical activity with a duration of between 5-45 minutes can reduce the sedentary activity per day. This in turn increases the physical fitness of the individual. Children who participate in school-based physical activity are also more inclined to engage in moderate or vigorous activity as opposed to those who do not (Dobbins et al., 2013). There have also been positive outcomes from changes in curriculae that promote physical activity.

Chapter Summary

Dance is then seen as a motivating, engaging and recommended form of physical activity for the advancement of motor skills, motor learning and motor development of children.

Children engaged in the phase of fundamental motor skills development, are seen to benefit vastly from dance. Locomotion will become more energy efficient. Movement will contain a greater stability and stronger synchronised flow.

Within context of this study gait and balance being fundamental motor skills can be a measure used to identify changes taking place between children aged four to six and eleven to fourteen. This will distinguish whether dance is more effective during the fundamental motor pattern or at the skilfulness phase of motor development.

Chapter 3

Methodology

Research Design

This was an empirical study that made use of quantitative methods to generate data (Chow, 2002) using a pre-test post-test design. The principle behind this design involves randomly assigning participants between two groups, an intervention group and a control group. Both groups engaged in the pre and post-testing of dependent variables, however the ultimate difference between the two groups was that a dance training was administered with an intervention (independent variable), while no additional exercises were given to the control group. This design allowed for a comparison of the final results of the post-test between both groups in an attempt to ascertain the overall effectiveness of the dance intervention.

Research Setting

This study took place at two schools within the Western Cape Province, South Africa. The testing was done at selected schools in unoccupied classrooms, and was administered by the investigator after school hours. The dance training was provided by a qualified Indian dance instructor. The dance intervention also took place in the unoccupied classrooms of the school that received the intervention in order to ensure sufficient lighting for videography. The working space was open plan and sufficient for dance lessons and movement to take place safely.

Sampling of Participants

Once permission to conduct the research was granted by the University of Western Cape, principals of four schools in the Western Cape were contacted to request participation in the study, of which two schools agreed. Each school consisted of approximately 60 grade R children between the ages of four and six years; and approximately 60 grade seven children aged between eleven and fourteen years. The grade R (4-6 year olds) group was chosen in order to identify whether dance as an extramural would result in any difference between an intervention group and control group. Magill (2007) has identified that the age of six years constitutes a turning point in both postural and locomotor equilibrium control. Therefore this age group was used to identify if dance training has any significant impact on top of their normal motor development.

One school was assigned as the control and the other as the intervention school. This decision was as a result of school premises availability and convenience of the dance trainer. Children and parents were provided with information regarding the research and those who were able to participate provided consent and then became part of the study as either the control group or the intervention group.

An information sheet detailing the study and consent forms should they be willing to allow their children to participate in the study. The children were then also asked to complete an assent form, written in simple language which they would understand, confirming their agreement to participate in the study. Acceptance to participate within this study was voluntary and from this a sample of one hundred and three participants was obtained.

Inclusion criteria

The following were included in the study:

- Participants who have given assent and received consent from their parents/guardians
- Participants had to be available during the after school duration of the study testing and intervention
- Participants had to be registered at the Primary school being used for the testing
- Participants were required to be in Grade R and Grade 7

Exclusion criteria

The following were excluded in the study:

- Participants who were injured, ill, or had other ailment prior or during the testing
- Participants who were unable to attend more than two of the dance intervention sessions were excluded from the results.
- Participants with cognitive, muscular conditions and diseases were excluded.

Research Procedures

This study was conducted using four groups, a Grade R and Grade 7 intervention and a Grade R and Grade 7 control. Ethics approval; to conduct the research was granted by the University of Western Cape Senate Research Committee (14/9/31). Parents or guardians of participants were provided with an information sheet which gave detailed explanation of the project (Appendix A) after which they were requested to complete a consent form (Appendix C). An explanation of what was required was given to the participants (Appendix B) followed by the completion of an assent document (Appendix D). This study made use of videography of the participants in which consent for this was provided and appropriate storage of data and analysis was essential to ensure participant confidentiality.

The format the research followed is listed briefly below:

Part 1: Sampling of Participants, gathering of consent and assent.

Part 2: Pre-Test

- 10 meter walk test
- Tandem gait
- Tandem stance balance

Part 3: Intervention (intervention group only)

A 6-week period of dance training provided to all those were selected to participate in the study. This sequence of dance training was dependent on age group as abilities varied.

Part 4: Post-Test

- 10 meter walk test
- Tandem gait
- Tandem stance balance

Research Instruments

This study used three different testing instruments as a means of measurement and data collection. For gait, a 10-meter walk test was used to identify the various stride measurements that take place during gait. For balance, a dynamic balance test known as the tandem gait and a static balance test known as the tandem stance was used. Both the control and experimental group were required to perform these tests before and after the intervention period.

Gait

10-meter walk test

The participants were captured on video while walking along a measured 10-meter track. The camera and tripod was set straight to ensure an accurate angle of shot. The video recording was taken of the participant's feet walking towards and away from the camera. Videos were recorded using the Kodak ZI8, which is a compact, high definition camcorder, using 720 x 1080 pixels and a 16:9 aspect ratio. Video files were directly downloaded to a computer via an USB cable. This test made use of a 10-meter walkway, with the video camera mounted where 1 meter in front of the walkway that recorded participants walking towards and away from the camera, Figure 3.1 displays the set-up.

Figure 3.3. Set-up of video for 10-meter walk test

Analysis of stride pattern

The stride pattern analysis was done using Kinovea software (version 0.8.15) in which magnification; time representation; and measuring features were used. The parameters collected during normal gait by means of videography included:

- Stride length
- Stride frequency
- Stride speed

Stride length was obtained by measuring the distance between the toes during a single heel strike of the gait cycle. Figure 3.2 displays the stride length measurements in meters. The stopwatch feature of Kinovea was used to obtain the time(s) taken to cover 6-meters. The reason for it only being 6-meters of timed data was to allow for 2-meters of acceleration and deceleration at either end of the 10-meter walkway. The stride frequency which was the number of steps per second was calculated by identifying the total number of steps walked for 6-meters and dividing this by the total time in seconds to walk the 6-meters. The stride speed was calculated using the total distance of 6-meters divided by the total time(s) walked for the 6-meters, recorded in meters per second ($m \cdot s^{-1}$).

Figure 3.4. Stride length measurements using Kinovea's measuring and magnification features.

Balance

Tandem gait balance test

Tandem gait is a high demand activity requiring careful control of centre of gravity movement and the establishment of a stable, narrow base of support. Tandem gait balance test involved counting the number of steps that could be taken in a heel-to-toe fashion before the child deviated from a taped line on the floor. This was conducted on the measured 10-meter walkway. The starting position was that of comfortable base support, eyes open and hands alongside the trunk. If either foot moved outside of the line of if arms were abducted or flexed more than 45 degrees then the counting of steps was terminated.

Analysis of the tandem gait balance test

Using visual analysis, the distance taken in a balanced fashion was recorded by watching the participant walk along a single line.

Tandem stance balance

"Tandem stance is a clinical measure of standing balance to assess postural steadiness in a heel-to-toe position by a temporal measurement" (Jonsson, Seiger, & Hirschfeld, 2005). The ability to stand in a heel-to-toe position reflects the degree of postural steadiness with a narrow base of support in the medial/lateral (M/L) direction. The tandem stance was used to assess stability by means of the duration in which the stance was maintained. The participant was tested with eyes open and then eyes closed. The timing commenced when the participant placed the one foot in front of the other foot on the straight line and time ended strictly when the participant either:

- used their arms (i.e., uncrossed arms),
- displaced any foot,
- moved the foot from original position/ stepping.

The procedure was repeated 3 times and and the best (longest duration) time was used for analysis.

Analysis of the tandem stance balance test

The longest time (seconds) for each open-eyed and closed-eyed balance test was recorded as each child's best score and used in the final comparison.

Intervention

Dance Training

The intervention programme consisted of Indian dance sessions that were instructed by a qualified Indian dance instructor. The sessions were conducted once a week for a total of 6 weeks. These six sessions lasted one hour each, starting off with a 5-minute warm up and ending with a 5-minute cool-down. The 50-minute of Indian dance was of moderate intensity and the routine consisted of simple steps, making use of the upper and lower body in simultaneous repetitive movements. The dance routines were choreographed to Indian music from Bollywood movies. The dance sessions were held in the school hall or an unoccupied classroom. Dance training for both Grade R and Grade 7 were the same, however the pace of a lesson was varied to cater for the younger Grade R children. A dance schedule and lesson plan can be found in Appendix F.

Analysis of data

The data collected were analysed statistically using IMB SPSS statistics software (version 23). Under the guidance of a statistician, paired t-tests within each age group were employed to compare the variables pre- and post-test; and an independent t-tests used to compare the variables between the control to invention groups. Furthermore, a correlation between Grade R and Grade 7 was conducted to identify any relationship between age and each dependent variable.

Chapter 4

Results

The purpose of this study was to examine the effect of Indian dance on gait and balance of Grade R and Grade 7 children. For the study of gait stride pattern, was examined in terms of stride length, stride frequency and stride speed, through the 10-meter walk test. For the study of balance; tandem gait, open and closed eyed tandem balance was examined, by measuring the distance walked in a heel-toe tandem fashion and the duration in which a balanced stance could be maintained respectively.

Sample Characteristics

Two schools were selected to participate in this study: the participants in the intervention group were recruited from one school and the control group from another school. Both were government schools from the same geographical region, therefore children were considered to be from equal socioeconomic circumstances. One hundred and three (103) children volunteered to participate in this study. The school classified as the control consisted on forty-eight (48) participants and the intervention school consisted of fifty-five participants (55). Each participant provided assent and parental consent prior to any testing being conducted. The children from the two schools consisted of two age groups: Grade R children between the ages of 4-6 and Grade 7 children between the ages of 11-14. The demographic data is supplied below in Tables 4.1 – 4.3.

Table 4.1: Gender demographics of participants

Gender	n	%
Male	50	48.5
Female	53	51.5
Total	**103**	**100**

Table 4.2: Age split per grade

	Age	n	%
Grade R	4	6	5.83
	5	34	33.01
	6	21	20.39
Grade 7	11	4	3.88
	12	17	16.50
	13	17	16.50
	14	4	3.88
Total		**103**	**100**

Table 4.3: Group size and mean ages in each respective grade

	Group	n	Mean Age
Grade R	Control	27	5.30
	Intervention	34	5.21
Grade 7	Control	21	12.62
	Intervention	21	12.38

Analysis of the Data

Results are presented as two parts. Part one consists of an analysis of the gait of children and consists of three stride pattern variables are presented, stride length, stride frequency and stride speed. The results of the analysis of balance are presented in part two and consist of the analysis of tandem gait, tandem balance eyes open (EO) and tandem balance eyes closed (EC).

The analysis of each variable will consists of the means and standard deviations of the pre- and post-test data separately. Following this, results from a paired t-test, which compared the difference between the pre-test and post-test are presented. This includes the, results from an Independent t-test which are presented to describe the difference that existed between the control and intervention groups. The above analysis is presented for both the Grade R and Grade 7 groups for the Stride Pattern and Balance variables.

The presentation of each variable concludes with a correlation coefficient(r) to identify the relationship that existed between the age and the pre-and post-test data of the variable in Grade R and Grade 7 for the children in the intervention group. The strength of the correlation is analysed using the guide of Field (2009), where positive and negative implies increasing or decreasing linear relationship between age and the variable respectively and strong ($r>0.50$) and weak ($r<0.50$) represents the correlation strength.

Stride Pattern

Analysis of Stride Pattern involved three variables: Stride length, measured in meters (m); stride frequency, expressed as the number of steps per second; and stride speed, measured in meters per second ($m \cdot s^{-1}$). The results of these tests are shown in the Tables below

Stride Length

Table 4.4 Stride length data for the Grade R children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Stride Length	GrRint	34	0.38±0.07	0.40±0.07	0.02	0.093
	GrRcon	27	0.42±0.07	0.43±0.06	0.01	0.051

* *Significant at p<0.05*

As can be seen no significant change occurred in stride length for the Grade R groups from pre- to post-test. The pre-test and post-test means for stride length in both GrRint and GrRcon are presented in Figure 4.1 below. However, on further analysis, by means of an Independent t-test conducted between the two groups, it is reported that the two Grade R groups were statistically different at both pre- (p=0.011) and post-test (p=0.018).

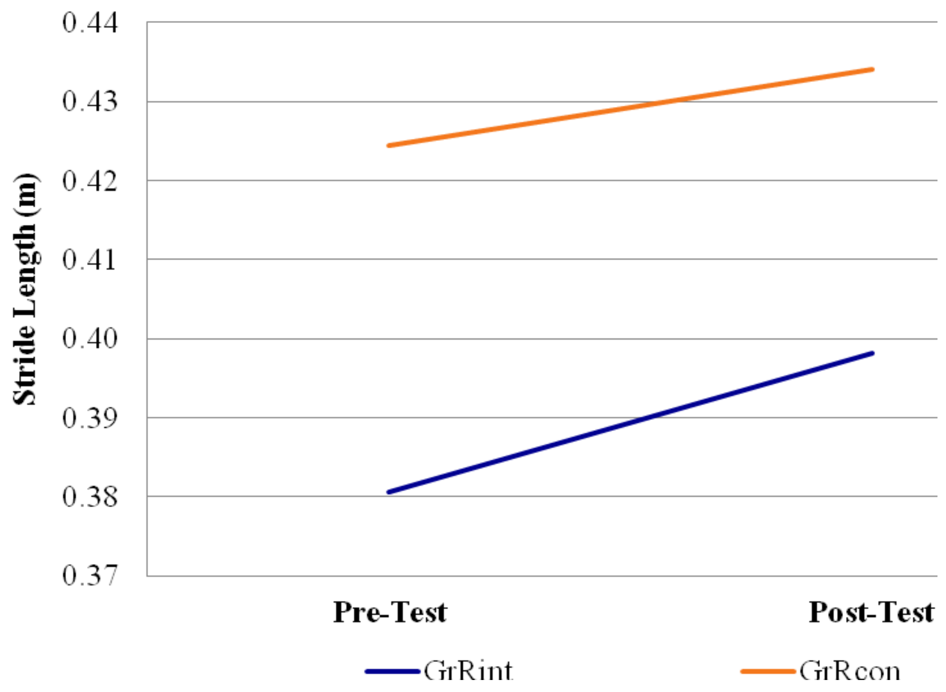


Figure 4.1: Comparison of means for stride length between Grade R groups

Table 4.5: Stride Length for the Grade R children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Stride Length	Gr7int	21	0.56±0.079	0.55±0.063	0.01	0.262
	Gr7con	21	0.52±0.069	0.52±0.071	0.00	0.427

* *Significant at p<0.05*

Figure 4.2 displays the data for stride length of the Grade 7 children. As can be seen, stride length decreased in the post-test Gr7int group but did not change in the Gr7con group, neither of these changes was found to be significant. A Paired t-test indicated no significant difference for either the Gr7int or the Gr7con group from pre- to post-test. Similarly, an Independent t-test between the intervention and control groups showed no significant difference between the groups at pre-test (p=0.071) or post-test (p=0.100) for stride length of Grade 7 children (Figure 4.2).

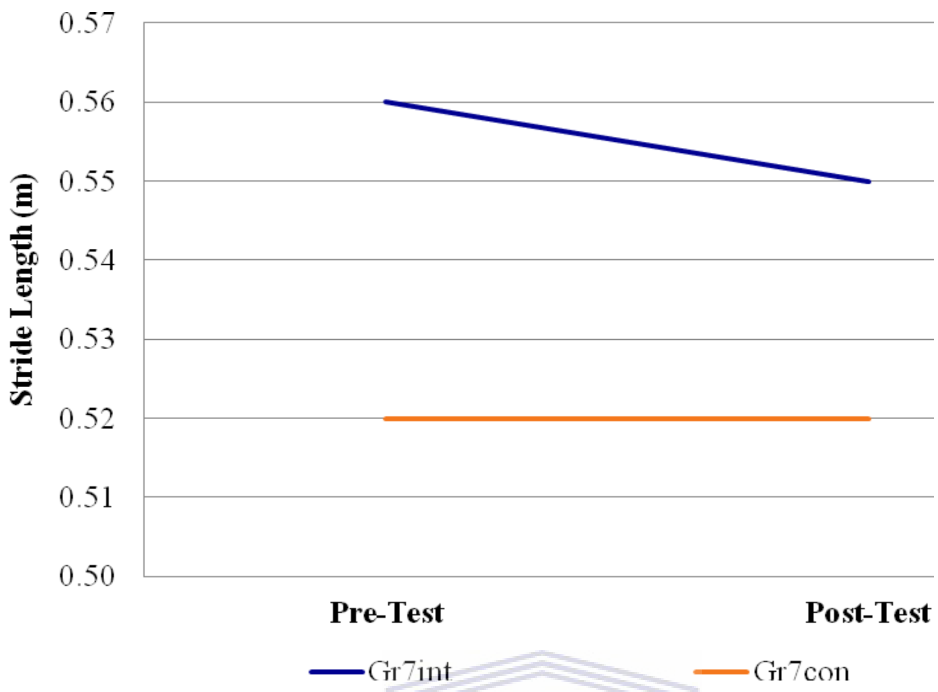


Figure 4.2: Comparison of means for stride length between Grade 7 groups

Grade R and Grade 7 Stride Length Relationship

The relationship that exists between age and stride length for the intervention groups (Grade R and Grade 7) is presented in Figure 4.3 below. This reports a correlation between age (years) and stride length (m) at both pre-test and post-test.

A strong positive linear relationship exists between age and stride length at both pre-test (r=0.77) and post-test (r=0.76). The coefficient of determination (R^2) depicts the variability between age and stride length at both pre-test (R^2=0.59) and post-test (R^2 = 0.58). Both of these R^2 values indicate that more than 50% of the children's stride length is related to age.

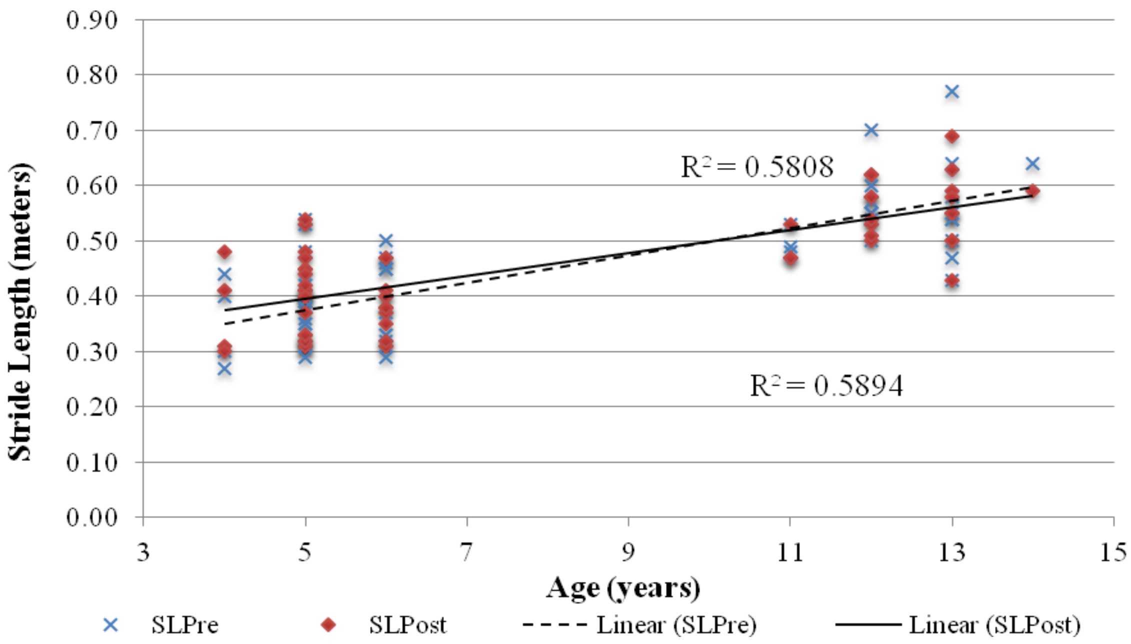


Figure 4.3: Correlation of stride length across the two age groups

Stride Frequency

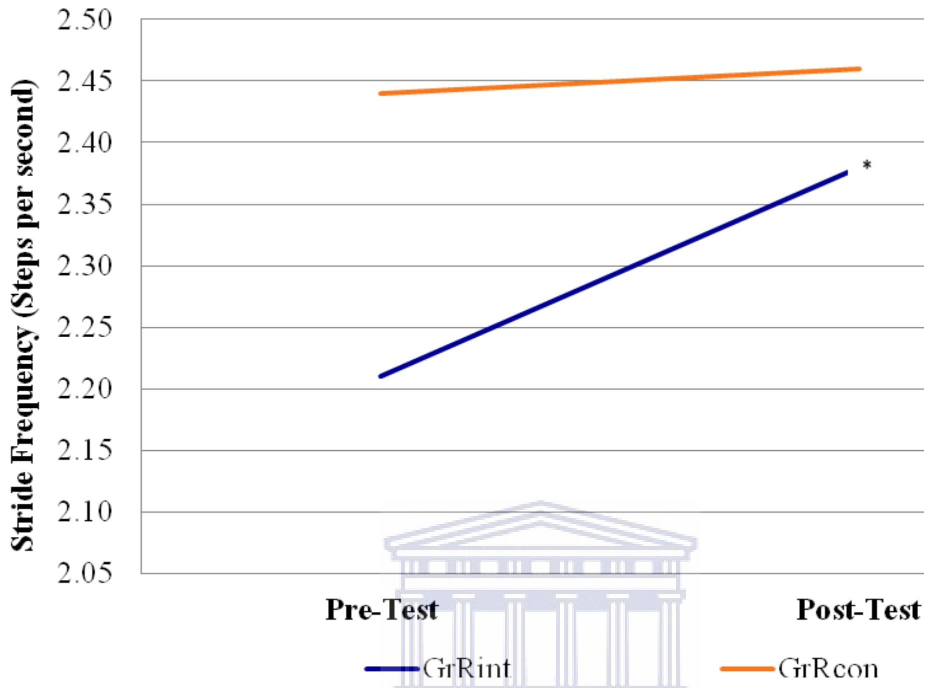
Table 4.6: Stride frequency data for the Grade R children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Stride Frequency (steps per second)	GrRint	34	2.21±0.29	2.38±0.39	0.17	0.009*
	GrRcon	27	2.44±0.35	2.46±0.35	0.01	0.232

* *Significant at p<0.05*

As can be seen a significant change occurred within the GrRint group and no significant change occurred within the GrRcon group from pre- to post-test. The pre-test and post-test means for stride frequency in the Grade R children are presented in Figure 4.4 below and it can be seen that the post test of both the GrRint and GrRcon group increased. However, on further analysis by means of an Independent t-test conducted between the two groups reported a significant difference between the

Grade R groups at pre- (p=0.004) but no significant difference in the post-test (p=0.218).



* *Significant at p<0.05*

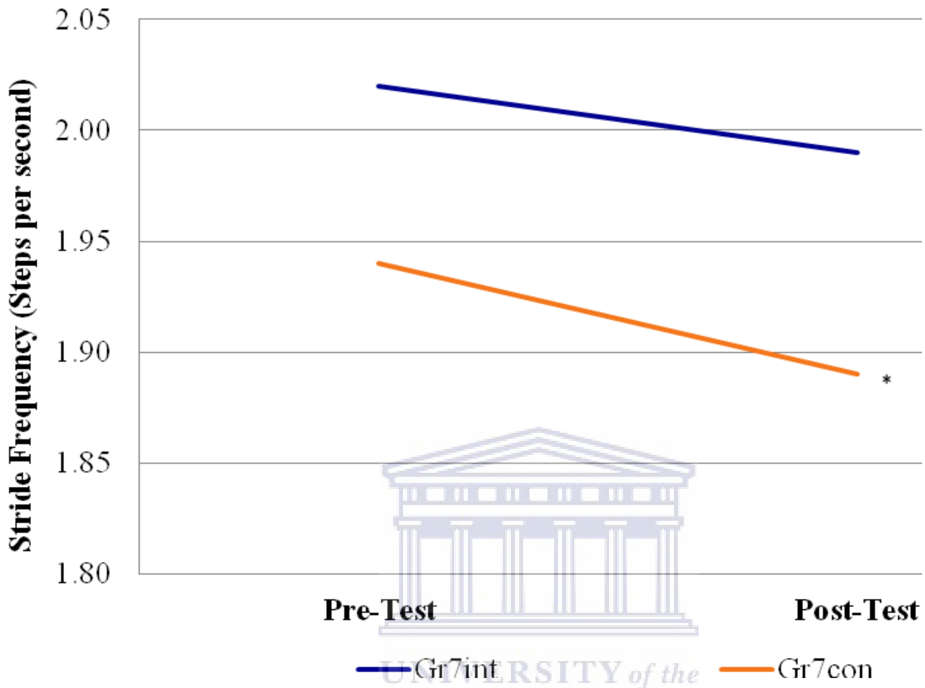
Figure 4.4: Comparison of means for stride frequency of the Grade R groups

Table 4.7: Stride frequency results for the Grade 7 children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Stride Frequency (steps per second)	Gr7int	21	2.02±0.17	1.99±0.14	0.03	0.116
	Gr7con	21	1.94±0.21	1.89±0.25	0.05	0.028*

* *Significant at p<0.05*

Figure 4.5 displays the stride frequency scores for the Grade 7 children. As can be seen, stride frequency decreased in the post-test of the Gr7int and the Gr7con groups. Paired t-test (Table 4.6) reported a significant decrease in the Gr7con group with the intervention group showing no significant change. From the Independent t-test between the intervention and control groups, no significant difference was present at both the pre-test (*p*=0.084) and post-test (*p*=0.061) for stride frequency of Grade 7 children (Figure 4.5).



* *Significant at p<0.05*

Figure 4.5: Comparison of means for stride frequency of the Grade 7 groups

Grade R and Grade 7 Stride Frequency Relationship

The relationship that exists between age and stride frequency in the intervention groups (Grade R and Grade 7) is presented in Figure 4.6 below. This depicts a correlation between stride frequency (number of steps per second) and the age (years) at both the pre-test and post-test.

A weak negative linear relationship exists between stride frequency and age at both pre-test (r=0.16) and post-test (r=0.33). The coefficient of determination (R^2) reports the variability between age and stride frequency of both pre-test (R^2=0.03) and post-test (R^2=0.11). Both of these R^2 values indicated that less than 15% percent of the children's age is related to stride frequency.

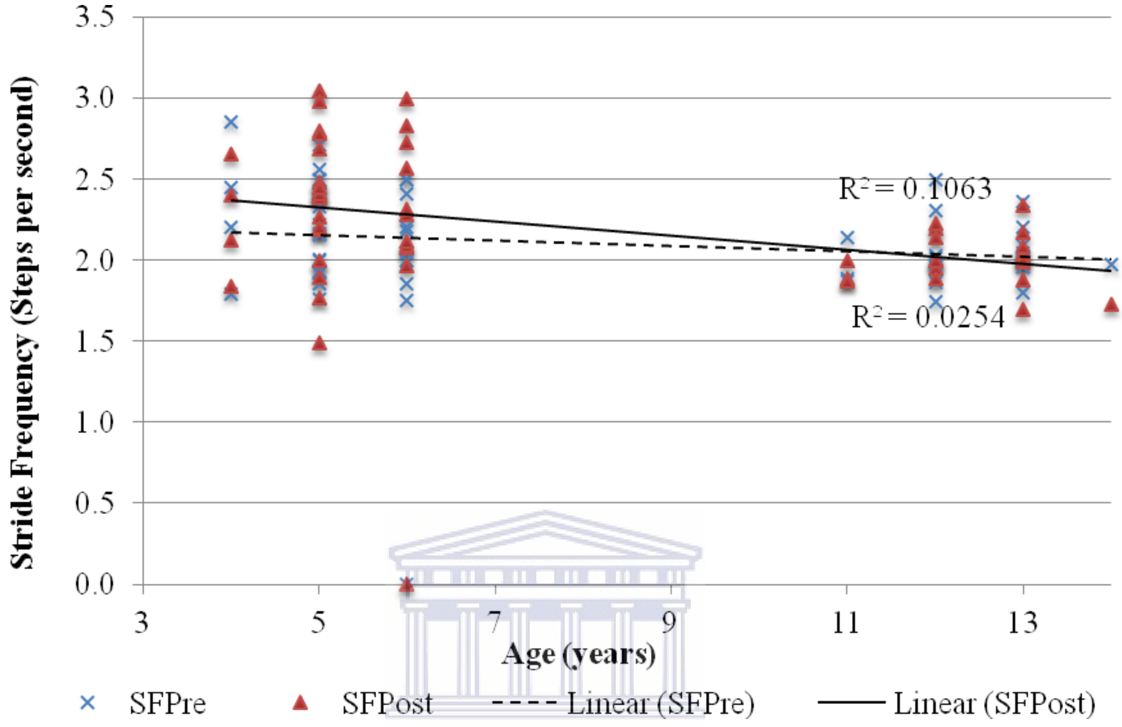


Figure 4.6: Correlation of stride frequency across the two age groups

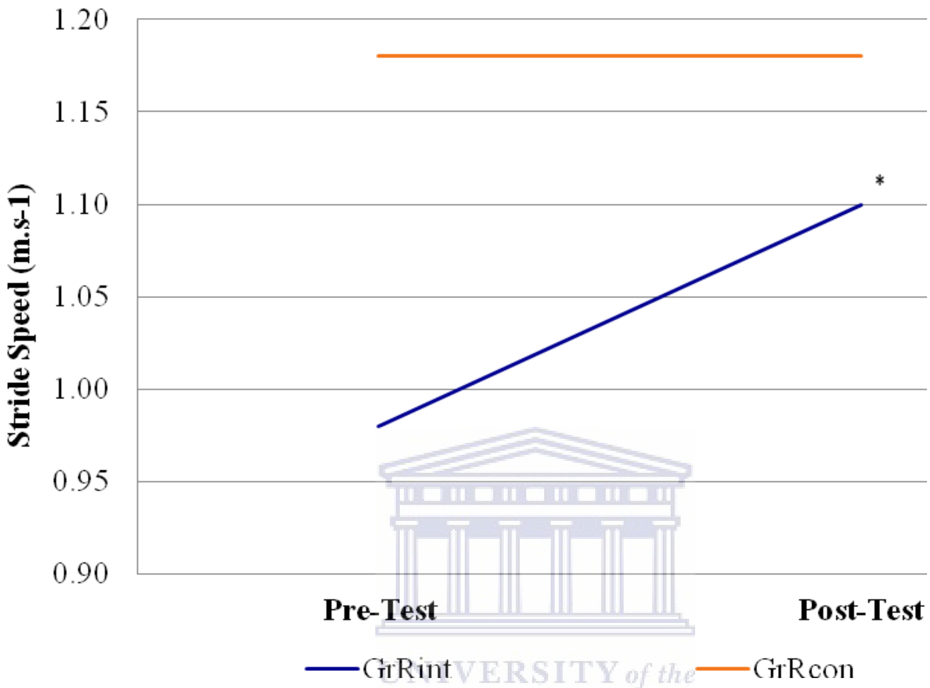
Stride Speed

Table 4.8: Stride speed results for the Grade R children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Stride Speed	GrRint	34	0.98±0.19	1.10±0.16	0.12	0.001*
	GrRcon	27	1.18±0.20	1.18±0.19	0.01	0.300

* *Significant at p<0.05*

As can be seen a significant increase occurred within the GrRint group and no significant change within the GrRcon group from pre- to post-test. The pre-test and post-test means for the stride speed in the Grade R children are visually displayed in Figure 4.7 below. However, on further analysis by means of an Independent t-test conducted between the two groups a significant difference between the Grade R groups at both pre- (p=0.000) and post-test (p=0.035) was reported.



* *Significant at p<0.05*

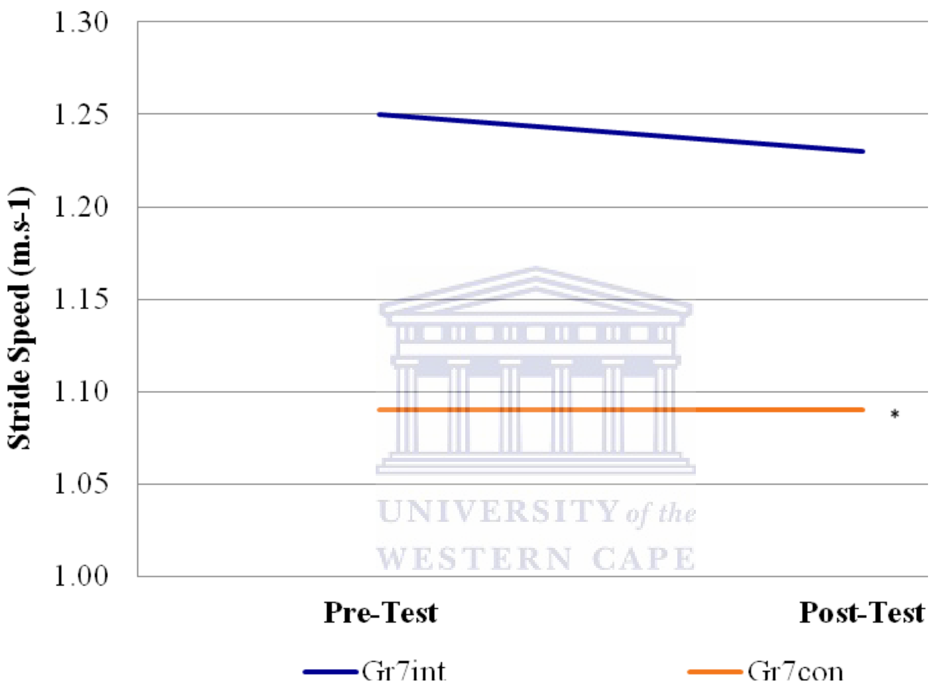
Figure 4.7: Comparison of means for stride speed of Grade R groups

Table 4.9: Stride speed results for the Grade 7 children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Stride Speed	Gr7int	21	1.25±0.12	1.23±0.12	0.02	0.076
	Gr7con	21	1.09±0.16	1.09±0.16	0.00	0.004*

* *Significant at p<0.05*

The Figure 4.8 displays the stride speed data for the Grade 7 children. As can be seen, stride speed decreased from pre- to post-test in the Gr7int group and remained constant for the Gr7con groups. A Paired t-test (Table 4.6) indicated a significant difference in the Gr7con group only, with no significant differences found in the Gr7int group. However an Independent t-test between the intervention and control groups, reported that both the Gr7int and Gr7con display a significant difference between the groups at pre-test (p=0.001) and post-test (p=0.001) for stride speed of Grade 7 children (Figure 4.8).



* *Significant at p<0.05*

Figure 4.8: Comparison of means for stride speed of Grade 7 groups

Grade R and Grade 7 Stride Speed Relationship

The relationship that exists between age and stride speed for the two intervention groups (Grade R and Grade 7) is presented in Figure 4.9 below. This graph reports a correlation between the group age (years) and stride speed (m.s^{-1}) at both the pre-test and post-test.

A strong positive linear relationship exists between age and stride speed and age at pre-test (r=0.65) however a positive but weak correlation exists at post-test (r=0.43). The coefficient of determination (R^2) displays the variability between age and stride speed of both pre-test (R^2=0.43) and post-test (R^2=0.19). The R^2 values identified that 43% for pre-test and 19% for post-test of the children's age is related to stride speed.

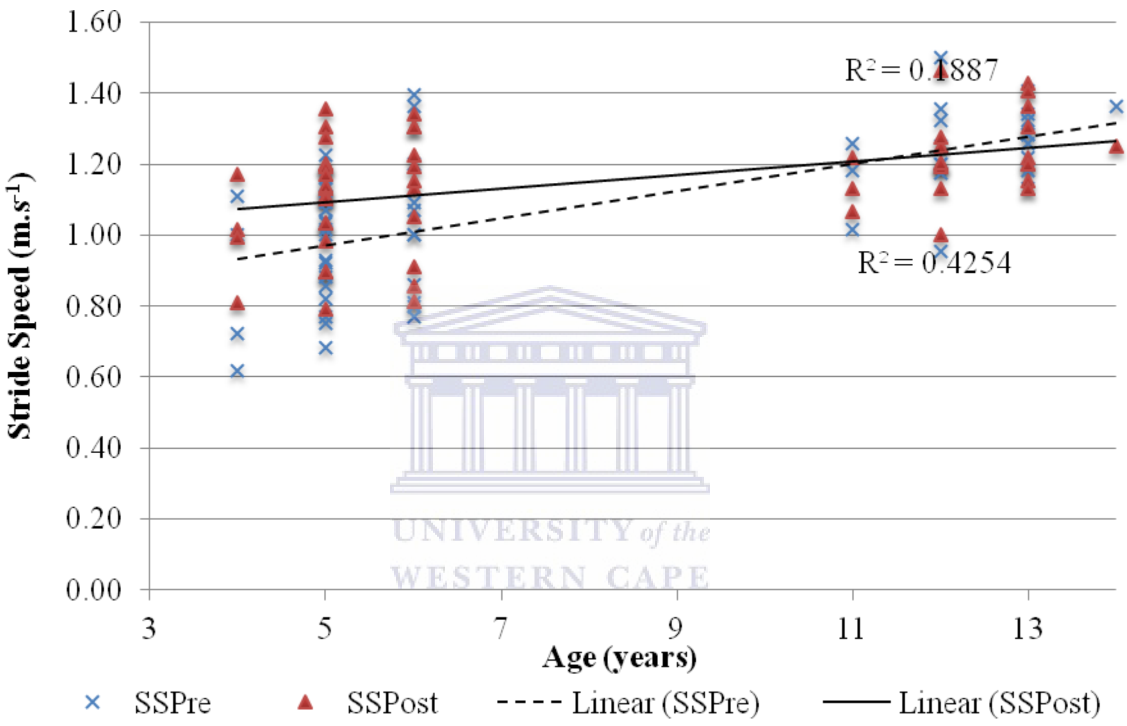


Figure 4.9: Correlation of stride speed across the two age groups

Balance

Analysis of balance tests tandem gait measured in meters (m); tandem balance eyes open measure in seconds (s) and tandem balance eyes closed measured in seconds(s), results are shown in the tables below.

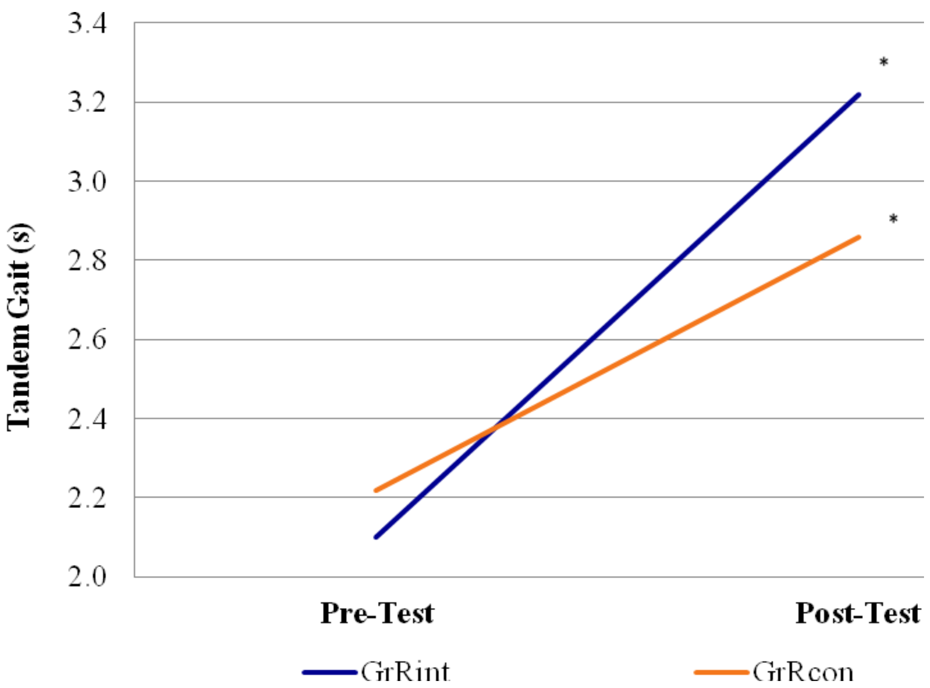
Tandem gait

Table 4.10: Tandem gait results for the Grade R children

Variable	Group	N	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Tandem Gait (m)	GrRint	34	2.10±1.50	3.22±1.58	1.13	0.000*
	GrRcon	27	2.22±1.55	2.86±1.62	0.63	0.001*

* *Significant at p<0.05*

As can be seen a significant change occurred within both groups from pre- to post-test. The pre-test and post-test means and standard deviations of the tandem gait for Grade R children are visually displayed in Figure 4.10 below. However, on further analysis by means of an Independent t-test conducted between the two groups that no significant difference (p<0.05) between the Grade R groups at both pre- (p=0.379) and post-test (p=0.189) occurred.



* *Significant at p<0.05*

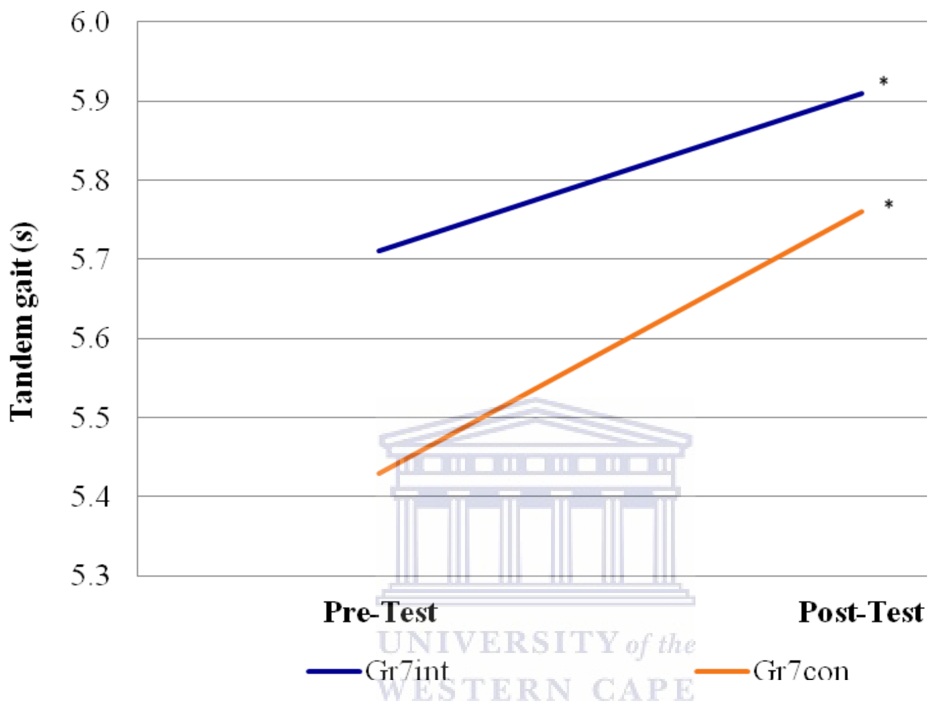
Figure 4.10: Comparison of means for tandem gait of Grade R groups

Table 4.11: Tandem gait results for Grade 7 children

Variable	Group	N	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Tandem Gait (m)	Gr7int	21	5.71±0.51	5.91±0.29	0.2	0.010*
	Gr7con	21	5.43±0.87	5.76±0.41	0.33	0.006*

* *Significant at p<0.05*

Figure 4.11 displays the results of tandem gait for the Grade 7 children. As can be seen, tandem gait increased significantly in the post-test of both the Gr7int and the Gr7con groups. A Paired t-test (Table 4.8) indicated that a significant difference exists in both the Gr7int and the Gr7con groups. However an Independent t-test between the intervention and control report no significant difference between the groups at both pre-test (p=0.104) and post-test (p=0.093) for tandem gait of Grade 7 children (Figure 4.11).



* *Significant at p<0.05*

Figure 4.11: Comparison of means for tandem gait of Grade 7 groups

Grade R and Grade 7 Tandem Gait Relationship

The relationship that exists between age and tandem gait for the intervention groups of (Grade R and Grade 7) tandem gait is presented in Figure 4.12 below. This reports a correlation between age (years) and tandem gait (m) at both the pre-test and post-test measurements.

A strong positive linear relationship exists between age and tandem gait at both pre-test (r=0.80) and post-test (r=0.70). The coefficient of determination (R^2) reports that the variability between age and tandem gait of both pre-test (R^2=0.64) and post-test (R^2 = 0.50). The R^2 values indicated that 50% of the children's age is related to tandem gait.

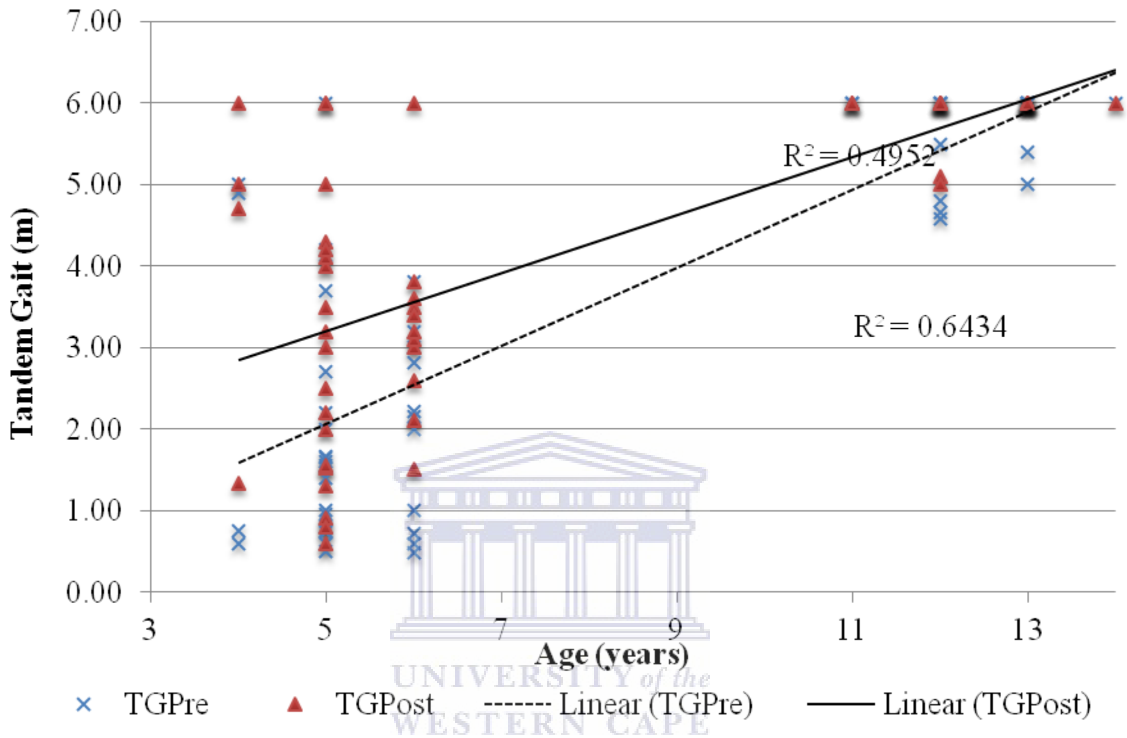


Figure 5Figure 4.12: Correlation of tandem gait across the two age groups

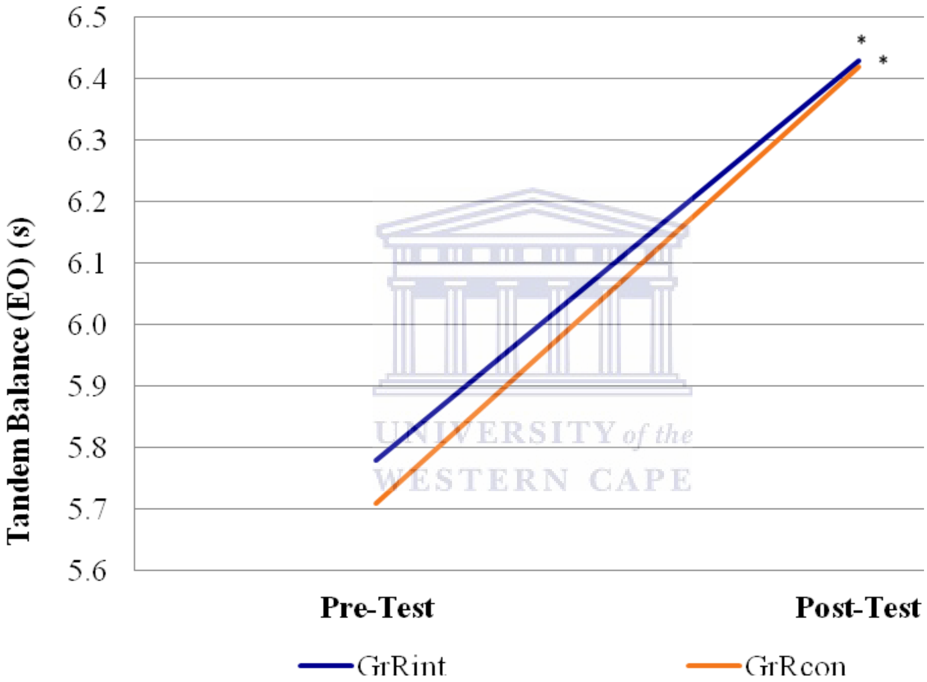
Tandem Balance Eyes-open (EO)

Table 4.12: Tandem balance (EO) results for the Grade R children

Variable	Group	N	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Tandem Balance (EO)	GrRint	34	5.78±1.55	6.43±1.80	0.65	0.006*
	GrRcon	27	5.71±2.06	6.42±1.60	0.71	0.003*

* *Significant at p<0.05*

As can be seen a significant change occurred within both the GrRint and GrRcon groups from pre- to post-test. The pre-test and post-test means and standard deviations of the tandem balance (EO) for Grade R children are visually displayed in Figure 4.13 below. However, on further analysis by means of an Independent t-test conducted between the two groups, no significant difference between the Grade R groups at both pre- (p=0.438) and post-test (p=0.498) is reported.



Significant at p<0.05

Figure 6Figure 4.13: Comparison of means for tandem balance (EO) of the Grade R groups

Table 4.13: Tandem Balance (EO) results for Grade 7 children

Variable	**Group**	**n**	**Pre-test Mean±SD**	**Post-test Mean±SD**	**Mean Difference**	***p*-value**
Tandem Balance (EO)	Gr7int	21	15.55±6.46	15.13±4.52	0.41	0.380
	Gr7con	21	14.63±5.54	14.61±4.93	0.02	0.479

* *Significant at p<0.05*

The tandem balance (EO) scores for the Grade 7 children are displayed in Figure 4.14. As can be seen, tandem balance (EO) decreased from pre-test to post-test of the Gr7int group and remained constant in the Gr7con group, however neither change was significant. A Paired t-test (Table 4.8) indicated that no significant difference was found in the Gr7int group and Gr7con group. An Independent t-test between the intervention and control groups, reported that there was no significant difference between the groups at pre-test (p=0.312) or post-test (p=0.361) for tandem balance (EO) of Grade 7 children (Figure 4.14).

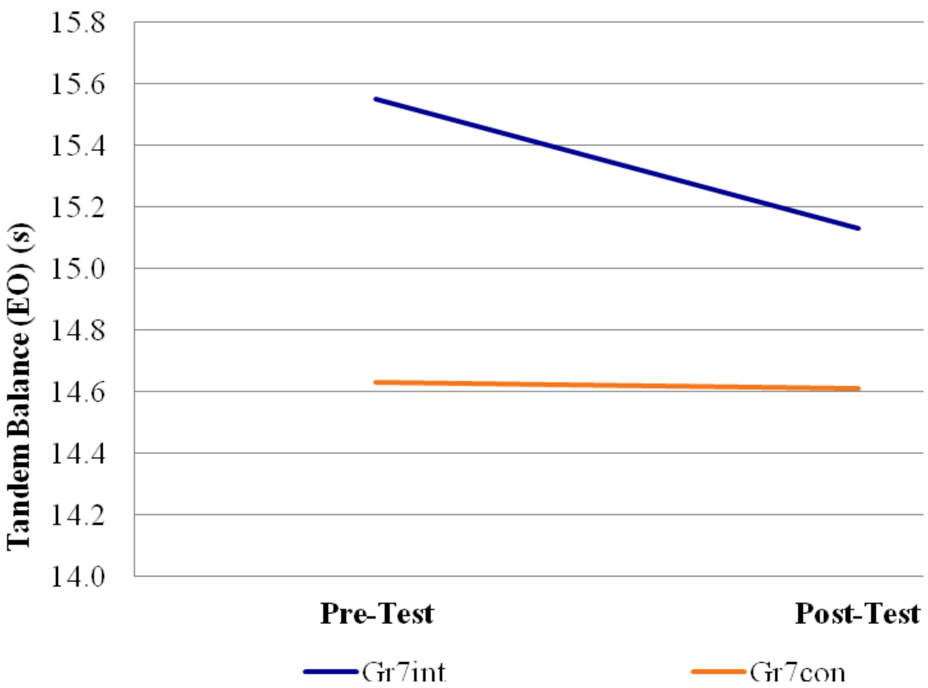


Figure 7Figure 4.14: Comparison of means for tandem balance (EO) of the Grade 7 groups

Grade R and Grade 7 Tandem Balance (EO) Relationship

The relationship that existed between age and tandem balance (EO) for the intervention groups (Grade R and Grade 7) is presented in Figure 4.15 below. This reports a correlation between age (years) and tandem balance (EO) (s) using both the pre-test and post-test measurements.

A strong positive linear relationship exists between age and tandem balance (EO) at both pre-test (r=0.79) and post-test (r=0.74). The coefficient of determination (R^2) displays the variability between age and tandem balance (EO) at both pre-test (R^2=0.55) and post-test (R^2 = 0.63). The R^2 values indicated that more than 50% of the children's age is related to tandem balance (EO) at both time points.

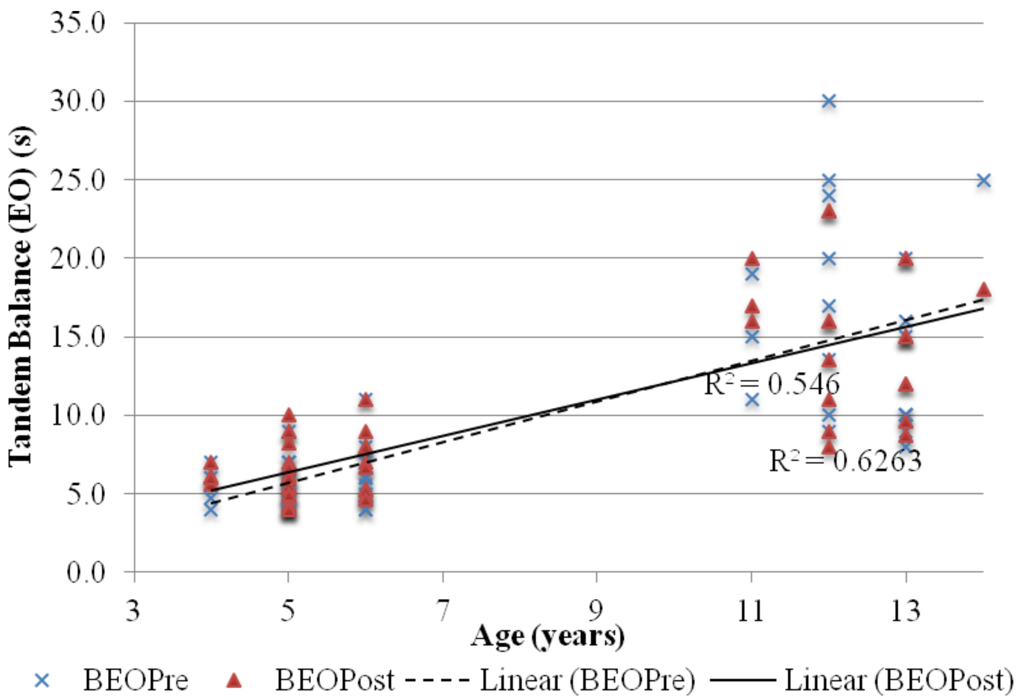


Figure 4.15: Correlation of tandem balance (EO) across the two age groups

Tandem balance Eyes Closed (EC)

Table 4.14: Tandem balance (EC) results for the Grade R children

Variable	Group	n	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Tandem Balance (EC) (s)	GrRint	34	3.39±1.49	3.65±1.51	0.26	0.300
	GrRcon	27	3.20±2.41	3.31±1.86	0.11	0.608

* *Significant at p<0.05*

From Table 4.7 it can be seen that no significant change occurred within the GrRint group and GrRcon group from pre- to post-test. The pre-test and post-test means and standard deviations of the tandem balance (EC) for Grade R children's are visually displayed in Figure 4.16 below. However, on further analysis by means of an Independent t-test conducted between the two groups, no significant difference between the Grade R groups at both pre- (p=0.352) and post-test (*p*=0.213) were noted.

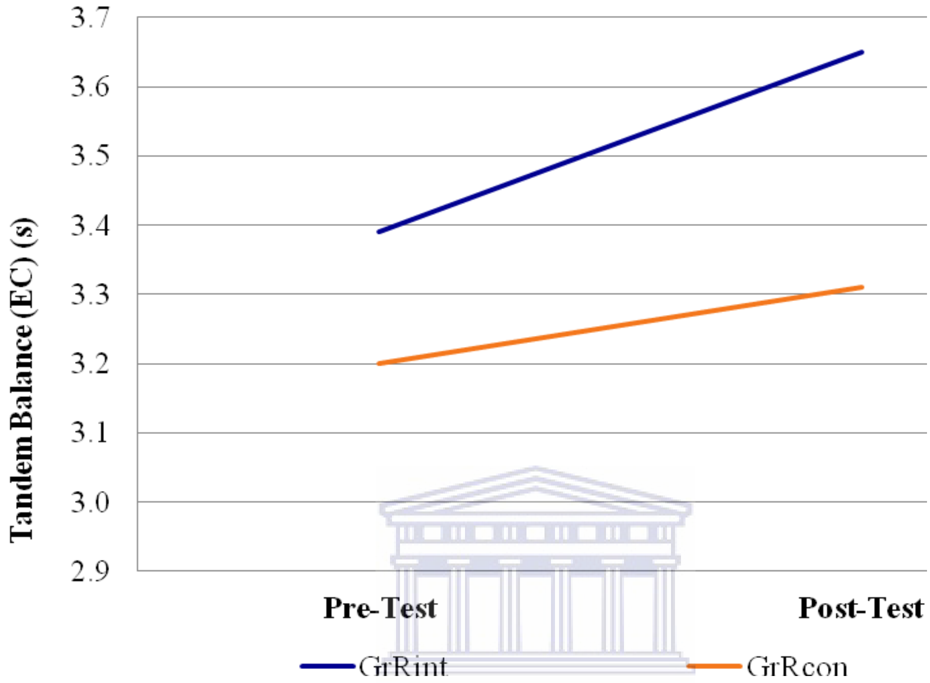


Figure 4.16: Comparison of means for tandem balance (EC) of the Grade R groups

Table 4.15: Tandem balance for Grade 7 children

Variable	Group	N	Pre-test Mean±SD	Post-test Mean±SD	Mean Difference	*p*-value
Tandem Balance (EC) (s)	Gr7int	21	9.03±4.07	8.90±3.28	0.13	0.839
	Gr7con	21	8.09±3.49	8.45±2.71	0.36	0.312

* *Significant at p<0.05*

Figure 4.17 displays the tandem balance (EC) scores for the Grade 7 children. As can be seen, tandem balance (EC) decreased in the post-test of the Gr7int group and increased in the Gr7con group, neither of these changes were significant. A Paired t-test (Table 4.8) indicated no significant differences were found in the Gr7int group and Gr7con group. Similarly, an Independent t-test between the intervention and control groups, reported that no significant difference between the groups at pre-test (p=0.213) or post-test (p=0.315) for tandem balance (EC) of Grade 7 children (Figure 4.17).

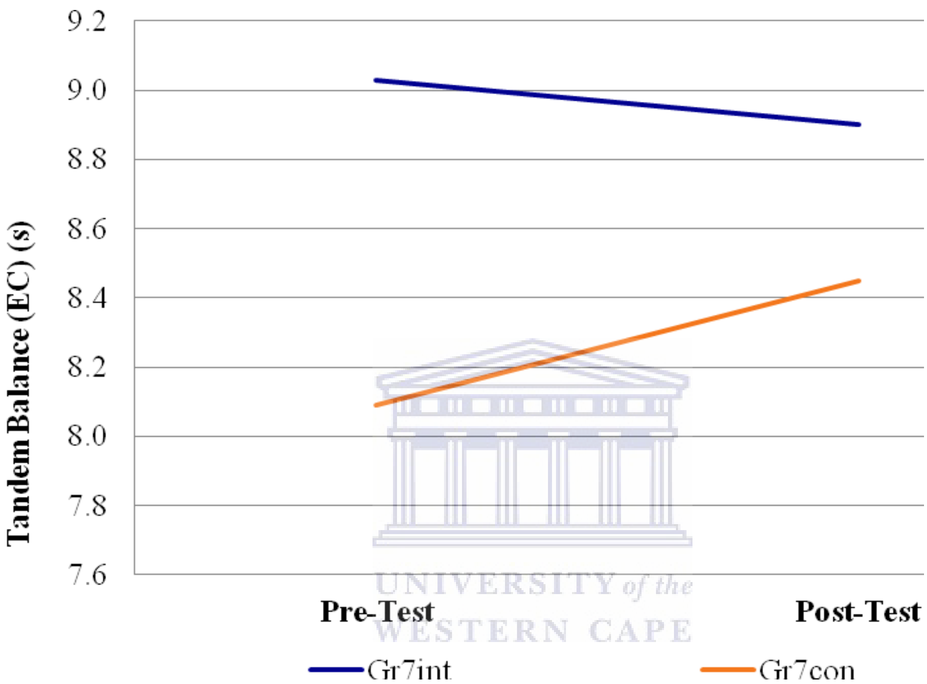


Figure 4.17: Comparison of means for tandem balance (EC) of the Grade 7 groups

Grade R and Grade 7 Tandem Balance (EC) Relationship

The relationship that exists between the age of the intervention groups of Grade R and Grade 7 and tandem balance (EC) is presented in Figure 4.15 below. A Pearson's correlation between of age (years) and tandem balance (EC) (s) using both the pre-test and post-test measurements was conducted.

A strong positive linear relationship exists between age and tandem balance (EC) at both pre-test (r=0.68) and post-test (r=0.75). The coefficient of determination (R^2) displays the variability between age and tandem balance (EC) at both pre-test

(R^2=0.47) and post-test (R^2=0.56). The R^2 values indicate that, at pre-test, 47% of the childrens' tandem balance (EC) is related to age, and was 56% at post-test.

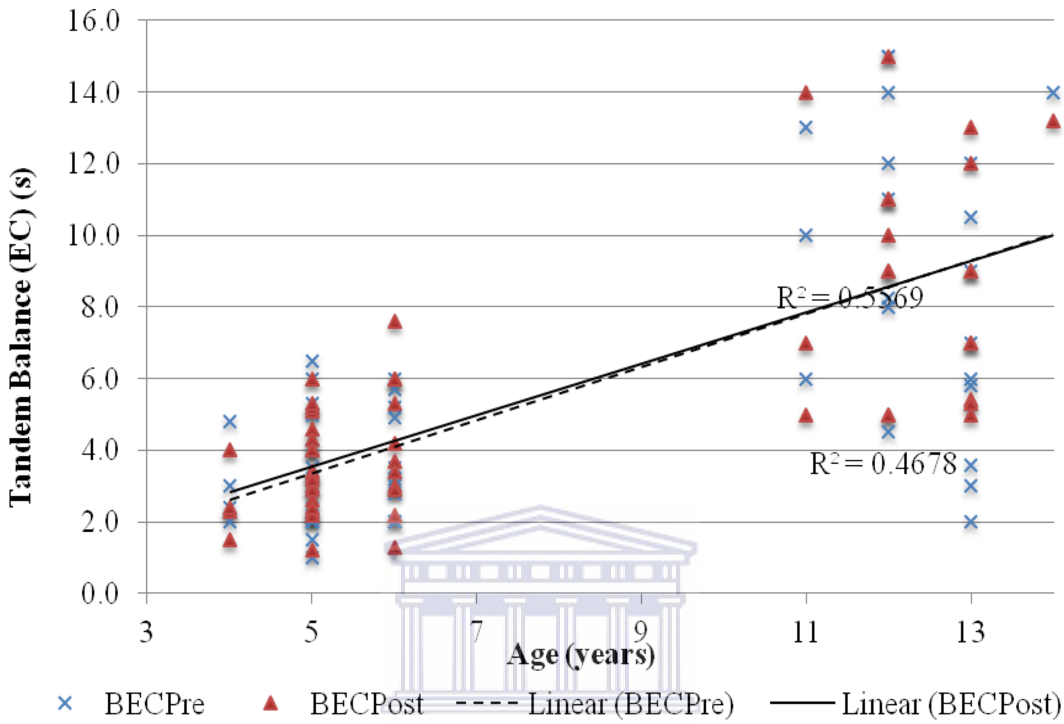


Figure 4.18: Correlation of tandem balance (EC) across the two age groups

Chapter Summary

This chapter has reported on the findings two-group, controlled intervention study. It was found that between the control and intervention groups the stride length of only the Grade R group and the stride speed of both the Grade R and Grade 7 groups displayed a significant (p< 0.05) difference. Therefore it can be said that the dance intervention had a significant effect on the stride length and speed. When comparing the control to intervention groups both the stride length and speed displayed a strong positive correlation with age, therefore stating that as a child gets older stride speed and stride length increase.

Through the investigation of the parameters of balance and stability it was identified that between the pre and post-test for tandem gait, both Grade R and grade 7 groups were significantly different ($p<0.05$). In other words, tandem gait increased over time, regardless of the dance intervention. A significant difference ($p<0.05$) for tandem balance eyes-open (EO) was noted for the Grade R group only, therefore the dance intervention had a significant effect on the younger group. Across all three variables of balance a strong positive correlation with age exists, therefore stating that as a child gets older balance increases.

The following chapter findings will be discussed in relation to previous research along with concluding factors of the study and recommendations for future research in this field.

Chapter 5

Discussion

This study made use of a pre-test post-test design in order to collect data. Data was collected to investigate and identify the effects of Indian dance on biomechanical and motor control variables of school children. The sample consisted of two age groups, Grade R and Grade 7, from two schools.

An important factor that affected the results of this study was the age group of children who participated, which was between two phases of the long-term athletic development (Balyi & Hamilton, 2004). The Grade R children were crossing over from 'Active Start' where fundamental skills are acquired into the 'FUNdamental' phase where skills are learned, practiced and developed. The Grade 7 children were in the 'Training to Train' phase of LTAD, where children are refining their sport-specific skills and building strength to execute these skills. This means that everything the Grade R children participate in will engage their fundamental motor development, therefore resulting in an enhanced sensorimotor effect. Whereas, the Grade 7 children, well-developed motor skills are already set and they would have to 'unlearn' to learn new skills.

In various studies, dance is seen as an enjoyable physical activity for children as well as a beneficial form of movement, which improves cardiovascular fitness and biomechanical factors, such as balance, gait, motor control and mechanical strength on both the physical and mental domains (Huang et al., 2012). It is reported that today's youth are at risk for obesity, thus fun activities, such as dance, can promote a healthier lifestyle and would help to fight this trend (Dehghan, Akhtar-Danesh, & Merchant, 2005).

The nature of this study incorporated a focused analysis of the effect of dance at two age groups. Specific tests were used in order to investigate the six objectives that were set to identify changes occurring in gait and balance in the individual age groups, plus a correlation coefficient between the age groups.

Stride Pattern

In children, stride pattern is dependent on various aspects including: age, gender and body composition, including variables such as height and leg length (Hausdorff, Zemany, Peng & Goldberger, 1999). Yet stride pattern can also be governed by external factors such as walking surface, carrying load, stride swing, time and various other aspects, all of which affect the way in which people walk (Tanawongsuwan & Bobick, 2003). Even though the electronic movement analysis systems such as the GAITRite electronic walkway has been identified as the gold standard for gait analysis, Chagas et al. (2013) found that an easily accessible and cost effective 10-meter walk test with videography provides similar gait analysis results with respect to stride length, cadence and velocity.

The normal human stride pattern is executed in a symmetrical alternating rhythm, this encourages greatest stability and less control requirements during locomotion (Shumway-Cook & Woollacott, 1995). This study used temporal distance factors such as stride length the distance between the toes at heel strike, stride frequency (the number of steps per second) and stride speed (the distance covered per second). The stride pattern findings and observations of literature compared to data from this study are presented below.

Stride length

The stride length of an individual will continuously increase until limb length and height have reached complete maturation and linear growth (Encheff, 2008). This is as a result of the pendulum gait pattern in which limb length directly influences stride length (Andrews, Goosey-Tolfrey, & Bressan, 2009; Rodriguez, Chagas, Silva, Kirkwood, & Mancini, 2013). From the pre- to post-test, the current study found that no significant increase took place for the Grade R intervention groups stride length. This lack of significance could be a result of the phase in which the Grade R children find themselves, i.e. in the 'FUNdamental' phase of The Mountain of Motor Development (Haibach et al., 2011), in which all manipulation and locomotor skills are gained. The intervention period lasted only six weeks, which may not have been sufficient time to display increases in height. This then could have resulted in the non-significant effect that dance had on stride length of children aged Grade 7, who would be in the 'Training to Train' phase of LTAD and the 'Skilfulness' phase of The Mountain of Motor Development (Haibach et al., 2011). During this phase, skilful behaviour and mechanically efficient work are enhanced, meaning that children aged Grade 7 have already developed their stride length. Therefore dance cannot be identified as the sole contributor to any increases in stride length.

Stride frequency

Hackney and Earhart (2010b) found that, when movement is synchronised to a rhythm and music, the facilitation of movement is enhanced. The current study observed that the Grade R intervention group reported a significant increase (p=0.009) in their stride frequency. This could be as a result of the rhythmic movement done to music stimulating the sensory integrating system. Thus motor calibration sensory feedback is enhanced for the use of controlled motor skill execution, especially in terms of rhythmical gait, increasing cadence, rate and frequency of walking (Sahli et al., 2013).

At the age of 4-7, children are developing their fundamental motor patterns, examples being walking and skipping (Haibach et al., 2011). Contralateral rhythm and patterns enhance coordination (Phillips, 2011), therefore dance skills, and, the age of Grade R is an effective time during the motor development of children to enhance rhythm and coordination of movement.

In accordance with the study by Chagas et al. (2013), where stride frequency decreased as age increases, the current study observed that stride frequency significantly decreased in the control group of children aged Grade 7. However this study found that only 15% of age is related to stride frequency, therefore variability across all ages can be expected. Therefore dance cannot be considered to be effective for this age group.

Stride Speed

Encheff (2008) stated that stride speed may be one of the best gauges for functional locomotion, which is simply calculated using speed or velocity; when distance and time walked are known. Changes in gait speed have also been found to result mostly from changes in stride length rather than frequency (Danion et al., 2003). However this study found that, upon the increase in Grade R stride frequency, which leads to increased stride speed, stride speed increased in the Grade R, contrasting with Grade 7 in which stride frequency and stride speed significantly decreased.

It appears that the significant increase in the stride speed in the Grade R children was influenced by the dance intervention. This can therefore be considered to be related to the fundamental phase of motor development in which these children find themselves. This means that dance has a positive, increasing effect on the Grade R children and a negative, decreasing effect on the Grade 7 control group. A dance intervention for people with Parkinson's Disease (Hackney & Earhart, 2010a) showed that, after 10 weeks of 1-hour partnered dance lessons, the six-minute walk test distance increased by small but continuous improvement. In the present study, six weeks of dance may have been an influencing factor on the improvement of stride speed, as shown in the significant change in Grade R children.

Therefore, from this study the dance intervention would effectively improve stride speed of children in Grade R, therefore resulting in greater motor proficiency and mobility.

Summary of stride pattern findings

Table 5.1 provides a summarised description of the stride pattern variables from the gait observed in the Grade R, Grade 7 and between the Grade R and Grade 7 children. This study found that stride frequency and stride speed increased in the Grade R intervention group and decreased in Grade 7 control group. This effect is a result of the dance intervention for the Grade R children and, specifically a result of the development stage at which the children are in.

Table 5.1: A summary of all stride pattern variables

	Grade R	Grade 7	Between Grade R & Grade 7	Contributing Factors
Stride Length	Significant differences at pre and post-test between the control and intervention	No significance observed	Strong positive correlation between age and stride length.	Small Height and lower limb length increases
Stride Frequency	Significantly increased between pre-and post-test of the intervention group	Significantly decreased between the pre- and post-test of the control group	Weak negative correlation. Stride frequency decreases with age.	Increased rhythmic skills.
Stride Speed	Dance significantly increased the stride speed.	Significant differences at pre- and post-test between the control and intervention	Strong positive correlation between age and stride speed.	Increased motor proficiency.

The stage of motor development for the Grade R children is the fundamental stage and for the 11-14 year old children is the skilfulness stage. The fundamental period stimulates the building up of a "*diverse motor repertoire*" which enables basic coordination for manipulation of objects and locomotion in an environment (Clark & Metcalfe, 2002). Whereas the skilful stage allows for confident application of motor behaviours with increased work output and decreased physical effort (Clark & Metcalfe, 2002). It was observed that the 4-6 year old children presented with increased coordination, by means of a significant stride frequency increase, and the 11-14 year old with a significantly decreased stride frequency which emphasises a possible decreased physical effort. Stride pattern was shown to develop with age, specifically stride length and stride speed increased as age increased. The study conducted by Chester, Tingley and Biden, (2006) suggests that five year olds display adult-like hip and knee kinetic patterns whereas adult-like ankle joint patterns are only revealed in children nine years and older. In the current study it can be the added resultant that stride pattern effects develop with age. The ankle joint patterns would also result in the increase of stride speed with age, as children develop stronger limb and joint stability, and a more confident stride pattern is then executed. These differences in stride pattern during the developmental periods of children are often the result of the changes in dimensions of the child's body which also to have an effect and impact on the child's motor development (Chagas et al., 2013). These include the onset of puberty which takes place at 11-13 years old where an increase in growth and strength are observed (Clark & Metcalfe, 2002).

The study conducted by Boonyong, Siu, van Donkelaar, Chou and Woollacott. (2012) explained that, throughout the gait cycle, an individual is required to constantly maintain stability and attention to control.

Balance

Postural control is an integral part of human orientation and stability. As the tasks of daily living vary and increase, so the sensorimotor system is required to adapt in order to enable controlled, stable motion (Shumway-Cook & Woollacott, 1995). Various studies have found that dance provides positive effects on balance and improves stability (Ricotti & Ravaschio, 2011; Rival et al., 2005; Shigematsu et al., 2002). Dance has also been considered an ideal physical activity for children, older adults, individuals with kinesthetic difficulties and lack of balance (Loeffler, 2007; Tsimaras, Giamouridou, Kokaridas, Sidiropoulou, & Patsiaouras, 2012). Hence, this study used traditional Indian dance as an intervention and assessed the effect it had on the Grade R and Grade 7 children. The intervention used a variety of Indian dance steps performed to music in the typical Indian style. Previous music and movement intervention programmes executed for long periods of time have shown to improve the dynamic balance of pre-school children (Scott, 2010; Zachopoulou et al., 2003).

This study allowed for both dynamic and static balance assessments. Both static and dynamic balance tests have been used to determine neuromuscular control, muscular strength, muscular endurance and range of motion (Condon & Cremin, 2014). In this study tandem gait assessed dynamic balance and both open eyed, and closed eyed tandem balance tests assessed static balance. These assessments were used in order to identify the effect of dance on the core components of an individual's stability and balancing ability within a narrow base of support. The balance findings and observations of literature compared with this study are presented below.

Tandem gait

Tandem gait is a simple test in which practice takes place as part of life (Krasnow, 2013), and at the age of five, children can usually manage the balance beam alone (Pica, 2008). The current study found that tandem gait improved significantly for all children aged 4-6 and 11-14 years over the six-week period of the intervention. This improvement, however, also occurred in the control group, suggesting that either a learning effect or motor skill development took place in the time frame that passed. When motor learning occurs, motor skills are remembered (Krasnow, 2013), in turn improving motor competency. Dynamic balance entails postural control while in motion and is a constantly engaged task used in all locomotion. The Grade R children were engaging in their first term of formal schooling when testing occurred, and the increase seen could have simply resulted from the increased time spent outdoors, or in their school playground, where they would be practicing tandem gait automatically. Similarly the Grade 7 children also presented with a significant increase in both the control and intervention group, which could have resulted from a learned effect where new motor tasks stimulate and result in increased performance (Dozza, Wall, Peterka, Chiari, & Horak, 2007). It was expected that dance would increase dynamic balance, however the results found that dance had no effect on the dynamic balance of children across both age groups.

Tandem balance (EO)

Dancers depend on their vision when learning to dance, in which skills such as 'spotting', or the delayed rotation of the head by fixed focus on one point when performing a pivot, are taught in order to assure balance and spatial orientation (Krasnow & Wilmerding, 2015). During a tandem stance the body is required to quickly focus its attention on controlling balance, preventing excessive sway (Sozzi, Honeine, Do, & Schieppati, 2013). Therefore the tandem stance was expected to improve post a dance intervention. However the current study found that tandem balance significantly increased in both the intervention and control group of the Grade R children and no significant difference was found in the Grade 7 children's tandem balance (EO). This shows that dance was not the factor resulting in the balance increase seen in Grade R children.

Pre-school children are at the phase in which fundamental motor skills and locomotion rely on balance, stability and postural control (Condon & Cremin, 2014; Shumway-Cook, & Woollacott, 2007). According to Balyi and Hamilton (2004), the Grade R children are at the FUNdamental stage of Long-Term Athletic Development

(LTAD), where these fundamental motor skills become autonomous. Any form of activity or motion should then result in improvements in balance, therefore over the intervention period of six weeks, children’s balance and stability was constantly being engaged. As expected, open-eyed static balance duration of the current study improved with age and this is in agreement with the study by Condon and Cremin, (2014), who found that balance is constantly improving at 6-7 years of age where the pattern of balance becomes more adult-like by the age of 10 years.

Tandem balance (EC)

With the elimination of visual inputs, an individual’s stability is carried out by vestibular and somatosensory inputs (Shumway-Cook & Woollacott, 1995). Shumway-Cook and Woollacott (1995) state that static balance is maintained for a longer duration with eyes open as opposed to eyes closed as all sensory mechanisms are in use. During a tandem stance with closed eyes an individual is unable to reduce sway regardless of instruction this is as a result of the unstable equilibrium and the demands of the task (Sozzi et al., 2013). As age increases so too does the ability to maintain a stable stance for a longer duration (Rival et al., 2005). The Grade 7 children presented with a more adult-like balance than the Grade R children while, most importantly, they were able to maintain a stance without visual feedback therefore establishing an enhanced sensorimotor system. They would have already developed and refined these skills, whereas the Grade R children would still be developing their fundamental movement skills. It was hypothesised that closed-eyed tandem balance would increase as a result of dance affecting the sensorimotor systems. However the dance sessions did not stimulate and engage movement without visual feedback, which then resulted in dance having no significant effect on the closed eye tandem.

Summary of balance findings

Table 5.2 provides a summarised description of the observed findings of balance in the Grade R, Grade 7 and between the Grade R and Grade 7. This study found that the tandem gait of both Grade R and Grade 7 and the tandem balance of only the grade R children increased significantly. This increase was found in the intervention as well as the control group, and this therefore means that the dance effect on the static and dynamic balance in this study was not significant. The phases of development these two groups found themselves in as well as the ability of these tests to be practiced would all increase the learned effect which would have altered the results.

Table 5.2: A summary of all balance variables

	Grade R	Grade 7	Between Grade R & Grade 7	Contributing Factors
Tandem Gait	Significantly increased between the pre- and post-test of both intervention and control.	Increased significantly between the pre- and post-test of both intervention and control.	Strong positive correlation between age and tandem gait	Learned effect in both Grade R and Grade 7
Tandem Balance (EO)	Increased significantly between the pre- and post-test of both intervention and control.	No significance observed	Strong positive correlation between age and tandem balance (EO)	Phase of motor development and learned effect
Tandem Balance (EC)	No significance observed	No significance observed	Strong positive correlation between age and tandem (EC)	Dance steps had no closed eye steps

However a strong correlation between age and all three parameters of balance was found, meaning that as age increased and children matured so did their balance. This can be as a result of the developed and enhanced ability to perceive and process sensory information and execute a controlled balance. From the age of eleven children have the ability to switch between different balancing strategies, with respect to feedback and feedforward control (Dhanani & Parmar, 2014). The feedforward system engages body sway without sensory input as opposed to the sensory feedback system which allows for switching between proprioceptive, vestibular and the visual systems in order to identify the body's orientation for balance control (Ting & Allen, 2014). With these systems matured movement becomes more stable as the most suitable orientation and balance strategy is used.

This study found that, in terms of a dance effect, a longer intervention period or an isolated setting in which children are not exposed to motor development would be the ideal to determine the balance parameter changes, however this defeats the purpose of dance and child development. The study is then found that dance had no direct effect on balance.

Conclusion

Movement can become effortless and automatic: with practice, skills become '*overlearned*' and the basal ganglia is activated, which in turn results in automatic, skilful execution of motor sequences (Adolph & Robinson, 2013).

Children need to be encouraged to play and participate in any form of physical stimulation. With the increase in obesity rates, any and all activities that promote movement should be encouraged. Dance can play a role in promoting this movement and healthier lifestyle and can play a great role in the somatosensory system and stimulate motor behaviour throughout an individual's development. Dance enables the mind and body connection and synchronisation. This results in stimulation of movement pattern which can be carried across all age groups. However, in this study, only the children aged 4-6 years old (Grade R) presented with a significant increased stride frequency. The possible cause of this change was that dance engaged the rhythmical pattern aspect of an individual's motor development. This then affected the stride frequency which can be seen in the rhythm aspect of stride pattern. Stride frequency is not necessarily affected by growth and changes with respect to age. Therefore, from this study, it can be seen that dance is an effective activity in significantly changing stride pattern in terms of stride frequency for the 4-6 (Grade R) children only. This is probably due to the nature of the movement in dance where children need to respond at a particular frequency to the music of the dance.

Furthermore, this study has found that regardless of the dance intervention the balance of all the children improved, meaning the dance intervention in itself was not an effective activity in improving balance alone. The 4-6 year olds just started school and were exposed to a new environment with varied movement opportunities. This therefore emphasises the effect of change and exposure to a variety of tasks which in turn engage the motor learning of children. Rival et al. (2005) found that balance improvements are greatest at the age of six; therefore children are at a point where any activity and form of play would result in balance enhancements. As for the 11-14 year old (Grade 7) children, a well-structured form of physical activity where the instructor focuses on improving motor skills would enhance and improve the daily activity.

This study then emphasizes the importance of diverse physical activities at a younger age. As one ages, rhythm and motor pattern are enhanced, which support a constant regular pattern of gait (Danion et al., 2003; Chagas et al., 2013; Rodriguez et al., 2013). Like the saying, "*You can't teach an old dog new tricks*". The 11-14 year old (Grade 7) children would require a longer period of time to change (re-learn) their current motor skills. One can therefore conclude that children in the younger age group and fundamental motor development phase will respond and should show increased benefits of dance, whereas children aged 11-14 (Grade 7) would be required to practice regularly in order to similarly respond to the benefits of dance. In this light, all training should be started at the young age, and that physical activity programs like dance are good and diverse options to consider when designing such activities.

Limitations

This study consisted of numerous limiting factors however key limitations are discussed below:

The small sample size many have existed due to the programme running as an extra mural activity and parents were unable to consent because the children were already committed to other activities. Children were engaged and committed to pre-arranged extramural activities consisting of religious as well as sport and physical activities. Transportation systems were already arranged before the year commenced and this also restricted a child from participation in this study. A larger sample would have added statistical power to the study, which enhances the ability to detect an effect whilst avoiding a Type II error or false negative (Field, 2009).

This research period took place at the commencement of the first term of the school year. The Grade R children coming either from home or a nursery school were at various stages of development and this first term allowed for exposure to increased new activities, play and motor learning therefore resulting in more motor patterns being stimulated and possibly affecting the findings.

The stability tests were simple and allowed for practise, this then may have increased the learned effect. A basic stability test had to be used to cater for the 4-6 (Grade R) children; however this test may have been very simple for the 11-14 (Grade 7) children, therefore affecting the results.

Traditional Indian dance styled steps were taught for the intervention, this then decreases the ability of this study to be easily replicated for different populations. Huang et al. (2012) made use of social dances which would have been more appealing in the cross-cultured school used for this study. The children also requested non-traditional, popular music for dancing. This may have resulted in a decreased effort and enthusiasm in which the children participated in the dance sessions.

The school environment that was used for the testing may have resulted in distractions when testing the stride and balance variables. Children were assessed in groups, and peers may have either distracted them or added pressure for performance. This may possibly have been the barrier in achieving the best executed balance and stride variables.

Lastly, the intervention period could have lasted two terms (or 20 weeks) and may have resulted in a larger effect of dance in the children aged 11-14(Grade 7).

Recommendations

For Research

Further research can be done making use of the vast biomechanical factors affecting locomotion, stability and environmental manipulation of children. The age groups used for the study can be increased or cover the entire primary school age group, this will assure and assist in identifying what form of motor development is taking place. Equipment with enhanced technological features can be used for example the GAITRite and force plate; however assurance of the mobility and efficiency would need to be considered.

Practical implications

For the purpose of teaching dance to children, small groups of no more than 10 children should be taught, unless an assistant teacher or control is present. This will result in more focused attention, which would provide for a more correct learning of the motor skills involved, and possibly an increased motor development.

Children have a tendency to become uninterested in constant repetitive activities, therefore change in music and structures of lessons are in order. The promotion of dance for all is vital, therefore all race and genders need to be included, and well catered for when teaching dance.

Dance in schools

The participation in physical activities such as dance can be seen as an important factor for self-esteem, health, education and, importantly, coordination. An increased amount of school-based extra-murals using dance would ensure that an enjoyable source of physical activity is taking place. With children being engaged in activities such as dance, it can become a habit and life-skill, which in turn can fight against global sedentary behaviours, the increased depression status, and encourage people to lead enjoyable, active lifestyles.

References

Adolph, K. E., Vereijken, B., & Shrout, P. E. (2003). What changes in infant walking and why. *Child development*, *74*(2), 475-497.

Adolph, K. E. & Robinson, S. R. (2013). The road to walking: What learning to walk tells us about development. *Oxford handbook of developmental psychology*, *1*, 403-443.

Andrews, B., Goosey-Tolfrey, V., & Bressan, E. S. (2009). The classification of sprinters with intellectual impairments: A preliminary analysis. *South African Journal for Research in Sport, Physical Education and Recreation*, *31*(2), 1-14.

American College of Sports Medicine. (2013). *ACSM's guidelines for exercise testing and prescription*. Lippincott Williams & Wilkins, Philadelphia.

Amos, P. (2013). Rhythm and timing in autism: learning to dance. *Frontiers in Integrative Neuroscience*, *7*(27), 1-15.

Assaiante, C. (1998). Development of Locomotor Balance Control in Healthy Children. *Neuroscience and Biobehavioral Reviews*, *22*(4), 527–532.

Balyi, I. & Hamilton, A. (2004). Long-term athlete development: Trainability in childhood and adolescence. *Olympic Coach*, *16*(1), 4-9.

Berg, K. & Norman, K.E. (1996). Functional Assessment of balance and gait. *Clinics in Geriatric Medicine, 12*(4), 705-723.

Boonyong, S., Siu, K. C., van Donkelaar, P., Chou, L. S., & Woollacott, M. H. (2012). Development of postural control during gait in typically developing children: The effects of dual-task conditions. *Gait & posture*, *35*(3), 428-434.

Boswell, B. B. (2005). Rhythmic movement and dance. *Adapted Physical Education and Sport*, *1*, 415-433.

Brooke, H. L., Corder, K., Atkin, A. J., & van Sluijs, E. M. (2014). A systematic literature review with meta-analyses of within-and between-day differences in objectively measured physical activity in school-aged children. *Sports Medicine*, *44*(10), 1427-1438.

Bruyneel, A.V., Mesure, S., Pare, J.C., & Bertrand, M. (2010). Organization of postural equilibrium in several planes in ballet dancers. *Neuroscience Letters*, *485*(3), 228-232.

Chagas, D. V., Leporace, G., Praxedes, J., Carvalho, I., Pinto, S., & Batista, L. A. (2013). Analysis of kinematic parameters of gait in Brazilian children using a low-cost procedure. *Human Movement*, *14*(4), 340-346.

Chester, V. L., Tingley, M., & Biden, E. N. (2006). A comparison of kinetic gait parameters for 3–13 year olds. *Clinical Biomechanics*, *21*(7), 726-732.

Chow, S. L. (2002). *Methods in psychological research*. Psychological Research, In Encyclopedia of Life Support Systems (EOLSS), Eolss Publishers, Oxford, UK.

Clark, J. E. (2007). On the problem of motor skill development. *Journal of Physical Education, Recreation & Dance*, *78*(5), 39-44.

Clark, J. E. & Metcalfe, J. S. (2002). The mountain of motor development: A metaphor. *Motor development: Research and reviews*, *2*, 163-190.

Čoh, M., Jovanović-Golubović, D., & Bratić, M. (2004). Motor learning in sport. *Facta universitatis-series: Physical Education and Sport*, *2*(1), 45-59.

Condon, C., & Cremin, K. (2014). Static Balance Norms in Children. *Physiotherapy Research International*, *19*(1), 1-7.

Dance. (2015). In *Merriam-Webster.com*. Retrieved October 31, 2015, from http://www.merriam-webster.com/dictionary/dance

Danion, F., Varraine, E., Bonnard, M., & Pailhous, J. (2003). Stride variability in human gait: the effect of stride frequency and stride length. *Gait & Posture*, *18*(1), 69-77.

Davids, K. W., Button, C., & Bennett, S. J. (2008). *Dynamics of skill acquisition: A constraints-led approach*. Human Kinetics. Champaign, Illinois.

Dehghan, M., Akhtar-Danesh, N., & Merchant, A. T. (2005). Childhood obesity, prevalence and prevention. *Nutrition Journal*, *4*(1), 24.

Derri, V., Tsapalidou, A., Zachopoulou, E., & Kioumourtzoglou, E. (2001). Effect of a music and movement programme on development of locomotor skills by children 4 to 6 years of age. *European Journal of Physical Education*, *6*, 16–25.

Dhanani, S. D. & Parmar, L. D. (2014). Normative Values of Tandem and Unipedal Stance in School Children. *International Journal of Current Research and Review*, *6*(24), 24-30.

Dobbins, M., Husson, H., DeCorby, K., & LaRocca, R. L. (2013). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Systematic Reviews*, *2*, 1-260.

Dozza, M., Wall, C. III., Peterka R. J., Chiari, L., & Horak, F. B. (2007). Effects of practicing tandem gait with and without vibrotactile biofeedback in subjects with unilateral vestibular loss. *Journal of Vestibular Research: Equilibrium & Orientation*, *17*(4), 195.

Draper, C. E., Bassett, S., de Villiers, A., & Lambert, E. V. (2014). Results from South Africa's 2014 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health*, *11*(suppl 1), S98-S104.

Encheff, J. L. (2008). *Kinematic gait analysis of children with neurological impairments pre and post hippotherapy intervention*. (Doctoral dissertation, University of Toledo, OH).

Figura, F., Cama, G., Capranica, L., Guidetti, L., & Pulejo, C. (1991). Assessment of static balance in children. *Journal of Sports Medicine and Physical Fitness*, *31*(2), 235-42.

Field, A. (2009). *Discovering statistics using SPSS*. Sage Publications, London, UK.

Grosse, S. (2008). Balance and Gait Training: Critical for Child development. *ATRI Newsletter*. *1*(3): 4-5.

Guzmán-García, A., Johannsen, L., & Wing, A. M. (2011). Dance Exercise for Older Adults: A Pilot Study Investigating Standing Balance Following a Single Lesson of Danzón. *American Journal of Dance Therapy*, *33*(2), 148-156.

Hackney, M. E. & Earhart, G. M. (2010a). Effects of dance on balance and gait in severe Parkinson disease: a case study. *Disability and rehabilitation*, *32*(8), 679-684.

Hackney, M. E., & Earhart, G. M. (2010b). Effects of dance on gait and balance in Parkinson's disease: a comparison of partnered and non-partnered dance movement. *Neurorehabilitation and Neural Repair*, *24*(4) 384-392.

Haibach, P., Reid, G., & Collier, D. (2011). *Motor learning and development*. Champaign, IL: Human Kinetics.

Hausdorff, J. M., Zemany, L., Peng, C. K., & Goldberger, A. L. (1999). Maturation of gait dynamics: stride-to-stride variability and its temporal organization in children. *Journal of Applied Physiology*, *86*(3), 1040-1047.

Haywood, K. M. & Getchell, N. (2009). *Life span motor development* (3rd Ed.). Champaign, IL: Human Kinetics.

Heiberger, L., Maurer, C., Amtage, F., Mendez-Balbuena, I., Schulte-Mönting, J., Hepp-Reymond, M. C., & Kristeva, R. (2011). Impact of a weekly dance class on the functional mobility and on the quality of life of individuals with Parkinson's disease. *Frontiers in aging neuroscience*, *3*(14), 1-15.

Hillman, S. J., Stansfield, B. W., Richardson, A. M., & Robb, J. E. (2009). Development of temporal and distance parameters of gait in normal children. *Gait & Posture*, *29*(1), 81-85.

Howse, J. & McCormack, M. (2009). *Anatomy, Dance Technique and Injury Prevention*. London: A&C Black.

Huang, S. Y., Hogg, J., Zandieh, S., & Bostwick, S. B. (2012). A ballroom dance classroom program promotes moderate to vigorous physical activity in elementary school children. *American Journal of Health Promotion*, *26*(3), 160-165.

Jackson, K. (2012). *Physical Therapy: Balance and Gait Training*. Retrieved 13 June 2014, from http://ic.steadyhealth.com/physical_therapy_balance_and_gait_training.html.

Jain, S. & Brown, D. R. (2001). Cultural dance: An opportunity to encourage physical activity and health in communities. *Journal of Health Education*, *32*(4), 216-222.

Jonsson, E., Seiger, A., & Hirschfeld, H. (2005). Postural steadiness and weight distribution during tandem stance in healthy young and elderly adults. *Clinical Biomechanics*, *20*(2), 202-208.

Krasnow, D (2013). *Motor learning in dance*. Retrieved [11 August 2014] from http://www.4dancers.org/2013/01/motor-learning-in-dance/.

Krasnow, D. & Wilmerding, M. V. (2015). *Motor Learning and Control for Dance: Principles and Practices for Performers and Teachers*. Champaign, IL: Human Kinetics.

Loeffler, G. (2007). *Creative movement and dance in early childhood education*. Reston, VA: American Alliance of Health Physical Education and Dance.

Lorenzo-Lasa, R., Ideishi, R. I., & Ideishi, S. K. (2007). Facilitating preschool learning and movement through dance. *Early Childhood Education Journal*, *35*(1), 25-31.

Magill, R. A. (2007). *Motor learning and control: Concepts and applications*. New York: McGraw-Hill.

Martin, K. A. (2013). *Preserving Dance Forms in India Through Education and Performance: A Curriculum for Bollywood Dance* (Doctoral dissertation, Liberty University, VA).

Martinec, R. (2013). Dance movement therapy in the concept of expressive arts-therapy. *Hrvatska revija za rehabilitacijska istraživanja*, *49*(Supplement), 143-153.

Miller, C. (2006). Dance medicine: current concepts. *Physical Medicine and Rehabilitation Clinics of North America*, *17*(4), 803-811.

Mukherjee, S., Banerjee, N., Chatterjee, S., & Chatterjee, S. (2014). Effect of Practicing select Indian Classical Dance Forms on Body Composition Status Of Bengalee Females: An Anthropometric Study. *Indian Journal of Biological Sciences*, *20*, 40-48.

National Dance Education Organisation (2005). *Philosophy Underlying Early Childhood Standards*. Retrieved [10 August 2014] from http://www.ndeo.org/content.aspx?page_id=22&club_id=893257&module_id=55419.

Newell, K. M. (1991). Motor skill acquisition. *Annual Review of Psychology*, *42*(1), 213-237.

Paul, J. & Nagarajan. G. (2014). Effect of injured and uninjured lower limbs on dynamic balance among male professional footballers. *International Journal of Advanced Research*, *2*(4), 642-648.

Perrin, P., Deviterne, D., Hugel, F., & Perrot, C. (2002). Judo, better than dance, develops sensorimotor adaptabilities involved in balance. *Gait and Posture*, *15*(2) 187-194.

Phillips, A. (2011). The Value of Skipping as a Locomotor Development and Assessment Tool [Web log post]. Retrieved [12 Sepetermber 2015] from http://www.pikeathletics.com/blog/the-value-of-skipping-as-a-locomotor-development-and-assessment-tool.

Pica, R. (2008). *Physical education for young children: movement ABCs for the little ones*. Champaign, IL: Human Kinetics.

Powers, R. (2010). *Use It or Lose It: Dancing Makes You Smarter.* Retrieved [1 September 2014] from http://socialdance.stanford.edu/syllabi/smarter.htm.

Ricotti, L. & Ravaschio, A. (2011). Break dance significantly increases static balance in 9 years-old soccer players. *Gait & posture*, *33*(3), 462-465.

Rival, C., Ceyte, H., & Olivier, I. (2005). Developmental changes of static standing balance in children. *Neuroscience*, *376*(2), 133-136.

Roberts, K. J., Nelson, N. G., & McKenzie, L. (2013). Dance-related injuries in children and adolescents treated in US emergency departments in 1991–2007. *Journal of Physical Activity Health*, *10*(2), 143-150.

Rodriguez, E. B., Chagas, P. S., Silva, P. L., Kirkwood, R. N., & Mancini, M. C. (2013). Impact of leg length and body mass on the stride length and gait speed of infants with normal motor development: a longitudinal study. *Brazilian Journal of Physical Therapy*, *17*(2), 163-169.

Sahli, S., Ghroubi, S., Rebai, H., Chaabane, M., Yahia, A., Perennou, D., & Elleuch, M. H. (2013). The effect of circus activity training on postural control of 5-6 year old children. *Science and Sports*, *28*(1), 11-16.

Scott, J. L. (2010). *The effect of a metronome-based coordination training programme on the fundamental gross motor skills of children with motor development delays* (Doctoral dissertation, University of Stellenbosch, South Africa).

Shigematsu, R., Chang, M., Yabushita, N., Sakai, T., Nakagaichi, M., Nho, H., & Tanaka, K. (2002). Dance-based aerobic exercise may improve indices of falling risk in older women. *Age and Ageing*, *31*(4), 261-266.

Shumway-Cook, A., & Woollacott, M. H. (1995). *Motor control: theory and practical applications*. Philadelphia: Lippincott Williams & Wilkins.

Shumway-Cook, A., & Woollacott, M. H. (2007). *Motor control: Translating research into clinical practice*. Philadelphia: Lippincott Williams & Wilkins.

Sozzi, S., Honeine, J., Do, M., & Schieppati, M. (2013). Leg muscle activity during tandem stance and the control of the body balance in the frontal plane. *Clinical Neurophysiology*, *124*, 1175-1186.

Tanawongsuwan, R. & Bobick, A. (2003). *A study of human gaits across different speeds*. Retrieved [11 Jan 2016] from ftp://ftp.cc.gatech.edu/pub/groups/gvu/tech-reports/2003/03-01.pdf

Ting, L. H. & Allen, J. L. (2014). Neuromechanics of Postural Control. *Encyclopaedia of Computational Neuroscience.* New York: Springer. *547*(1), 1-4.

Tirosh, O., Sangeux, M., Wong, M., Thomason, P., & Graham, H. K. (2013). Walking speed effects on the lower limb electromyographic variability of healthy children aged 7–16years. *Journal of Electromyography and Kinesiology*, *23*(6), 1451-1459.

Tsimaras, V. K., Giamouridou, G. A., Kokaridas, D. G., Sidiropoulou, M. P., & Patsiaouras, A. I. (2012). The effect of a traditional dance training program on dynamic balance of individuals with mental retardation. *The Journal of Strength & Conditioning Research*, *26*(1), 192-198.

Verbecque, E., Lobo Da Costa, P. H., Vereeck, L., & Hallemans, A. (2015). Psychometric properties of functional balance tests in children: a literature review. *Developmental Medicine & Child Neurology*, *57*(6), 521-529.

Verstraete, S. J., Cardon, G. M., De Clercq, D. L., & De Bourdeaudhuij, I. M. (2006). Increasing children's physical activity levels during recess periods in elementary schools: the effects of providing game equipment. *The European Journal of Public Health*, *16*(4), 415-419.

World Health Organisation. (2015). *Physical activity*. Retrieved [24 July 2015] from http://www.who.int/topics/physical_activity/en/.

Woollacott, M. H. & Shumway-Cook, A. (1990). Changes in posture control across the life span—a systems approach. *Physical Therapy*, *70*(12), 799-807.

Zachopoulou, E., Derri, V., Chatzopoulos, D., & Ellinoudis, T. (2003). Application of Orff and Dalcroze activities in preschool children: Do they affect the level of rhythmic ability? *The Physical Educator*, *60*(2), 50-56.

Appendix A: Information Sheet – Parent/Guardian

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959-3688, Fax: 27 21-959-3137
E-mail: bandrews@uwc.ac.za

INFORMATION SHEET – PARENT/GUARDIAN

Project Title: The effect of Indian dance on the gait and balance of children: Comparing Grade R and Grade 7 children.

What is this study about?

This is a research project being conducted by Nikita Cara at the University of the Western Cape. We are inviting you to participate in this research project because your children are at a developmental phase, where many changes are occurring. The purpose of this research project is to identify which age group of children would display the greatest effects of dance on the gait (walk pattern) and balance. This study will also be a guideline in order to determine whether dance would have physical benefits to children.

What will I be asked to do if I agree to participate?

You will be asked to participate in a gait and balance test prior to any form of activity. Gait is simply known as walking pattern. The children will be divided into two groups, a control and a test group (dancing group). Those in the test group will be taught a series of dance items for a period of six weeks. This testing will be done at both Grade R and Grade 7 levels. The children will participate at their school, for one hour after school. This study will last for a period of 10 weeks.

Would my participation in this study be kept confidential?

Your personal information will be kept confidential. To help protect your confidentiality, our information will remain anonymous. All we require from your children would be there age, gender, height and weight. We will make use of videography, where videos will be stored without facial recognition. Our report or article about this research project will ensure your identity remains protected.

In accordance with legal requirements and/or professional standards, we will disclose to the appropriate individuals and/or authorities information that comes to our attention concerning child abuse or neglect or potential harm to you or others.

What are the risks of this research?

There may be some risks from participating in this research study. During physical activity there would be a risk of possible injury. There is always a risk of straining or spraining a

muscle during the dance sessions. Further risks may occur, if all physical and medical history is not disclosed.
There are no known risks associated with participating in this research project.

What are the benefits of this research?
This research is not designed to help you personally, but the results may help the investigator learn more about the effects of dance therapy on gait and balance. We hope that, in the future, other people might benefit from this study through improved understanding of the benefits that dance would have on children**.**

Do I have to be in this research and may I stop participating at any time?
Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

What if I have questions?
This research is being conducted by Nikita Cara of the Sports Recreation and Exercise Science Department *at* the University of the Western Cape.
If you have any questions about the research study itself, please contact:
Nikita Cara
0844615688
caranikky@gmail.com.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

HOD: **Prof A Travill**
Supervisor: **Dr. Barry Andrews**
University of the Western Cape
Private Bag X17
Bellville 7535
Telephone: (021) 959 2350
E-mail: atravill@uwc.ac.za

Dean of the Faculty of Community and Health Sciences: **Prof. J. Frantz**
University of the Western Cape
Private Bag X17
Bellville 7535
021-959 2631
chs-deansoffice@uwc.ac.za

This research has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee.

Appendix B: Information Sheet – Child

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959, Fax: 27 21-959 3137

E-mail: bandrews@uwc.ac.za

INFORMATION SHEET - CHILD

Title of research

The effect of Indian dance on the gait and balance of children: Comparing Grade R and Grade 7 children.

The aim of this research is to determine the effect of dance training on the performance of gait and balance of Grade R and Grade 7 children, and to investigate which age group would best demonstrate these effects.

About the study

Motor skills such as balance and gait are vital for the development of Movement. Dancing is a good to improve skills as it requires balance and helps one learn how to control their body movements. The purpose of this study is to investigate the effects that a series of eight weeks of dance lessons would have on the walking pattern and balance of two different age groups of children. Each group will each undergo a Star Excursion Balance Test and a Ten meter walk test for stride pattern analysis. The balance test will assess dynamic stability by providing a reach distance of eight points. The stride pattern analysis, will consist of comparisons between stride length, stride frequency and stride velocity by means of using videographic analyses.

Stopping the study

You will not be forced to join this study and you may stop taking part whenever you want to or need to. If you do stop the study, you will not get into any trouble and no one will force you to join again.

Permission

You will be asked to fill in a form saying that you agree to join the study.

Questions

Feel free to ask any questions at any time.

Our contact details:

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact:

Study Coordinator's Name: Miss Nikita Cara

Study Coordinator's Name: Dr Barry Andrews
University of the Western Cape
Private Bag X17, Belville 7535
Telephone: (021) 959 – 3137
Cell: 082 658-1552
Fax: (021) 959 – 3688

Email: bandrews@uwc.ac.za

Thank you for your time and effort, it is much appreciated.
This research has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee.

Appendix C: Consent Form

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 3137, Fax: 27 21-959 3688
E-mail: bandrews@uwc.ac.za

CONSENT FORM

Title of Research Project: The effect of Indian dance on the gait and balance of children: Comparing Grade R and Grade 7 children.

The study has been described to me in language that I understand and I freely and voluntarily agree to allow my child to participate. My questions about the study have been answered. I understand that my child's identity will not be disclosed and that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.

Participant's Parent/Guardian's name………………………..

Participant's Parent/Guardian's signature……………………………….

Date……………………….………

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact the study coordinator:

Study Coordinator's Name: Dr Barry Andrews
University of the Western Cape
Private Bag X17, Belville 7535
Telephone: (021) 959 – 3137
Cell: 082 658-1552
Fax: (021) 959 – 3688
Email: bandrews@uwc.ac.za

Appendix D: Assent Form

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 3137, Fax: 27 21-959 3688
E-mail: bandrews@uwc.ac.za

ASSENT FORM

Title of Research Project: The effect of Indian dance on the gait and balance of children: Comparing Grade R and Grade 7 children.

I have been told what this is all about in language that I understand and I have been told I do not have to do it if I do not want to, or that I can stop if I want, without getting into trouble. All my questions about what we will be doing have been answered. I understand that no one will know it was me in this study.

Participant's name……….....................……………….

Participant's signature……………………………….

Date………...……………

If I am not able to sign for myself, I verbally agree to participate in this study.

I testify to the fact that verbal consent was given

by……………………..………………. on

the…………………………………………

Witness name... Sign..

Should you have any questions regarding this study or wish to report any problems

you have experienced related to the study, please contact the study coordinator:

Study Coordinator's Name: Dr Barry Andrews

University of the Western Cape

Private Bag X17, Belville 7535

Telephone: (021) 959 – 3137

Cell: 082 658-1552

Fax: (021) 959 – 3688

Email: bandrews@uwc.ac.za

Appendix E: 10-Meter Walk Test

Gait Analysis is a method used in which to assess the way in which one walks. With the use of the 10-meter walk test, gait speed can be assessed over a 10-meter distance.

Verbal and visual demonstration needs be provided prior to testing. Participants will be asked to walk on a 10m walkway. The basic temporal gait parameters (gait speed, step length, and step frequency) will be collected during normal gait in order to identify stride pattern.

The camera and tripod is to be set straight to ensure angle of shot is accurate. Information will be recorded onto a memory card and transferred to a computer where the data will be analysed. The video recording will be taken of the participant's feet walking towards and away from the camera. For clear video recording there should be no disturbance in the surrounding environment hence a quiet setting will be ensured throughout the duration of videoing.

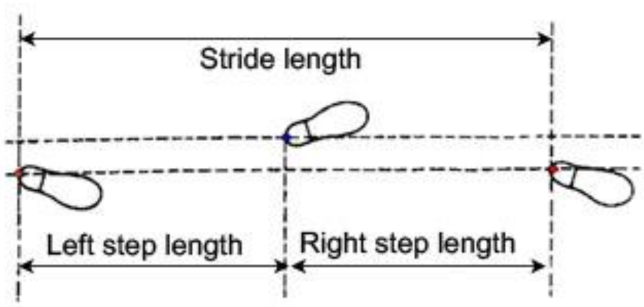


Figure 1: Display of step length versus stride length.
This measure is taken from heel strike to heel strike.

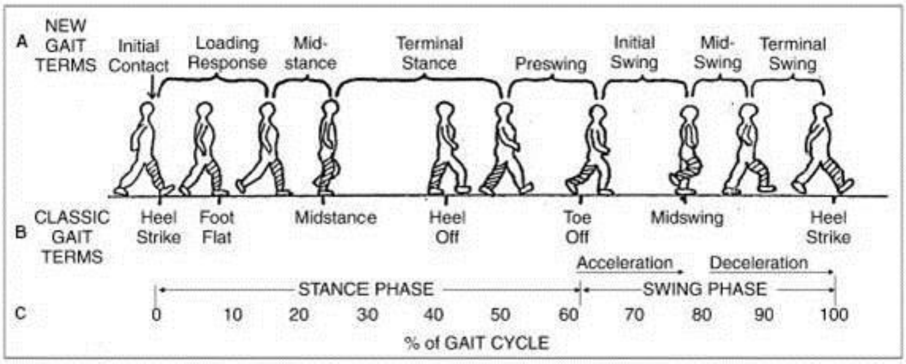


Figure 2: A diagram of the gait cycle, displaying the various patterns in which one walks.

General Test Instructions:

1. The child walks for 10 meters and the time is measured for the intermediate 6 meters to allow for acceleration and deceleration
2. Start timing when the toes of the leading foot crosses the 2-meter mark
3. Stop timing when the toes of the leading foot crosses the 8-meter mark

Set-up:

1. Measure and mark a 10-meter walkway
2. Add a mark at 2-meters
3. Add a mark at 8-meters

Patient Instructions (derived from the reference articles):

Normal comfortable speed: "I will say read, set, go. When I say go, walk at your normal comfortable speed until I say stop.

Figure 3: Various floor structure and markings that will be used for assessing gait.

Appendix F: Dance sessions

Duration: (3 February 2015 – 31 March 2015)

Instructional material:

- Tape recorder
- A CD with traditional and Bollywood Indian music

Session	
Week 1	Introduction to Indian dance steps by means of displaying a sequence. Teaching of the basics footwork: • Step-dig-step (tai tai tai) • Step-hop-step-dig • 3 Basic garba steps Teaching of basic hand work movements and Hastas (hand gestures): • Basic garba clapping Teaching of basic pattern work • Circles • Lines Application of work learnt to music repeatedly. Slow and medium tempo of music used
Week 2	Recap of previous lesson Footwork: • 4 Basic garba • And re-teaching of previous lessons footwork Arm movements • Basic garba clapping • Alaptmukha • Kataka mukha Teaching of basic pattern work • Circles • Lines • Doing steps while moving to different places Application of work learnt to music repeatedly. Slow tempo of music used

Week 3	Recap of previous lesson Application of steps to Gujarati garba music. Incorporation of steps at specific beats and adding pattern.
Week 4	The sound track Hookah Bar (dandiya garba mix) was used. The track was 2 minutes long Teaching of two new garba steps. Handwork included • clapping, • clicking • Alaptmukha • Kataka mukha
Week 5	The full track was choreographed.
Week 6	Practice of choreographed piece of music. Fixing and polishing of steps. Fun and different steps of which were shown and copied. Different Bollywood music tracks used.

Provisions and safety considerations:

- No chewing of gum
- Sufficient water supply
- Lavatory use prior to lesson